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PROBLEMS OF EMPLOYMENT IN AN AGEING POPULATION

THE thoughtful address on the employment of the older worker which Sir Frederic Bartlett delivered in October 1951 in the Centenary Lectures given under the auspices of the Ministry of Labour attracted comparatively little attention at the time. Its significance is emphasized by the report of the Royal Commission on Population, and is apparent from current discussions of the trend of population in Britain in the next few decades provoked by that report. It is now widely recognized that, in a society with an ageing population, it is desirable and even essential that the elderly should remain longer at work. As Sir Frederic Bartlett suggested, the increasing needs of humanity can only be met if all fit people, from youth to age, play their parts; and only if those parts, moreover, are planned in accordance with the natural flowering and growth throughout life of human abilities.

It is against this background that the importance and value of the work of the Nuffield Research Unit on the Problems of Ageing, established by the Foundation in the Psychological Laboratory of the University of Cambridge under Sir Frederic Bartlett, and Mr. F. Le Gros Clark's research on the continued employment of the elderly, are best appreciated. Some attention, it is true, was given to it at the Conference on Human Relations in Industry arranged by the Ministry of Labour and National Service in March 1952*, and the Labour Party's pamphlet "The Welfare State" recognizes that it is becoming imperative for old people to stay in employment, even if not in their recognized jobs or in a full-time capacity. The question of a later retiring age is frankly faced in this pamphlet, and, whereas it has generally become difficult even for those past forty to obtain fresh posts, the Post Office has become the first government department to practise the policy—which successive Governments have advocated since the War—of deliberately encouraging the elderly to apply for work. The maximum age of recruitment for postmen, van-drivers and telephonists has been raised from forty-five to sixty, and the Union of Post Office Workers has shown humanity and a proper understanding of national needs in agreeing to co-operate in working the new scheme.

While this scheme sets an example for industry generally to follow, the Chancellor of the Exchequer has tackled boldly the problem of retirement in the Civil Service, and ruled that Civil servants who are still capable of doing their job, and who wish to continue, need not retire at sixty. This, of course, means deferred promotion, and probably deferred increases in pay for others; but it is understandable that Mr. Butler has rejected a request from the Civil Service unions that those older than sixty who remain at work should be transferred to grades that do not block promotion. The Treasury will not wish to be

* Ministry of Labour and National Service. Report of the Human Relations in Industry Conference, held at the Institution of Civil Engineers, London, March 18–20, 1952. Pp. vi+128. (London: H.M.S.O., 1952.) 3*s.* 6*d.* net.

forced to transfer a man from some post where he is particularly useful, and it should be recognized, as the Minister of Labour points out in a pamphlet entitled "Employment of Older Men and Women", that while blocked retirement presents real difficulties for younger people, the increased expectation of life, as well as the raising of the retirement age, both tend to ensure that the ultimate tenure of senior posts by those whose path is temporarily blocked will not be shorter than under schemes of compulsory retirement.

That does not, of course, entirely dispose of the difficulty; but it could also be mitigated by measures for increasing salaries on merit, without necessarily waiting for promotion. Furthermore, there are men who would be happy enough to stay at work in a position of less responsibility, and, even in the Civil Service, it should not be impossible to deal with such cases without making hard-and-fast rules. Particularly where the most senior positions are concerned, this might indeed come to be the most usual situation for, as has been pointed out by H. R. Hill in a recent American book, "Some Observations on Executive Retirement", in a society where not only the population is ageing but also business and administration are becoming more complex, the strain of executive responsibility more onerous, and adaptability more important, age is a growing handicap less and less compensated by length of experience.

In such circumstances, it should be the normal rather than the exceptional practice for those who remain at work on passing what is at present regarded as the customary age of retirement, to step down or aside into other positions rather than continue in their existing posts. Such a practice very clearly involves considerable administrative problems, but it is manifestly one in the national interest and is fully supported by the trend of the research work to which Sir Frederic Bartlett referred. Opposition to the raising of the retirement age, such as that voiced by Mr. J. Haworth, treasurer of the National Federation of Professional Workers, appears to be out of keeping with both the trend of the change in age-structure of the population and the changes in national and social interests which must result.

Sir Frederic Bartlett's observations in the address noted were based upon the general results of the work of the Unit for Research into Problems of Ageing. Available evidence, he pointed out, implies that the great majority of a contemporary healthy population could continue efficiently and economically to meet the main demands of industry, at least up to what is still taken to be the normal span of life. There is no doubt, however, that for all manner of skills, from simple combined bodily movements to complex high-level mental skills requiring executive and administrative decisions based upon evidence collected from many sources, the overall preferred speed of work diminishes as age increases. If the speed of work is set by the conditions of work themselves, the cost of maintaining this speed, unless the methods of work are changed, may become much more punishing, especially over fifty.

This difficulty of speed, and especially imposed speed, cannot, Sir Frederic pointed out, be removed entirely by regard for what are called 'human relations', or by systems of management alone. Both can help, but the basic requirement is to plan operations, and especially the design of display and control, with the view of the most widely distributed natural range of abilities in whatever working populations are concerned, and in doing this to make age-group an important consideration. To do this—and Sir Frederic is certain it will have to be done—would make the problems of re-orientation, re-learning, and perhaps switch of occupation in the more advanced age-groups, acute and critical; but he sees no insuperable obstacles to such an extension of planned occupational design.

The Nuffield Unit is already providing a firm factual basis for policy, given the goodwill and the co-operation required to make any such policy effective. Moreover, as Mr. J. Marsh, director of the Industrial Welfare Society, noted, in dealing with the subject at the Human Relations Conference in March last year, industry needs to remember constantly the great help which the medical profession could give. It is already clear that men can carry on with manual skills for many years, though it is less certain that they can carry on with mental skills for so long. The main thing is to alter our attitude towards occupation and old age. Mr. Marsh suggested that, particularly in the administrative and clerical grades, we might need to explore the possibilities of interchangeable pension schemes so as to facilitate the movement of men between forty and fifty-five to jobs which gave them fuller scope, and that we also need to explore more fully the possibilities of what might be called 'demotion without disgrace'.

Discussions on the subject at this Conference pointed to the desirability of terminating old-fashioned artificial age-restrictions for certain employments, many of which are out of date to-day and only create ill-feeling and frustration. Nevertheless, the undesirability of persons remaining in positions of responsibility after they have passed the stage when they are fully effective was recognized; though to implement a policy of 'demotion without disgrace' a change of attitude is required, not only on the part of management but also of workers, if they are to accept that it may be necessary in old age to take a job of lower status and salary. So far as manual workers are concerned, there was agreement that the aim must be to secure that older persons willing and able to work should not be denied this opportunity on grounds of age alone. The test should be ability to do the job and not date of birth; but no compulsion to go on working should be applied to workers if they wish to retire.

It was agreed at this Conference that there is a widespread desire on the part of many workers to continue work past their present retiring age, and that employers should aim at transferring workers to more suitable work at any time when their age becomes a handicap. Skilled workers can generally be expected to carry on into old age in their normal

work, and the transfer process would affect only a small proportion of all manual workers. The possibility of making the change in middle life to jobs which could be carried on in old age merits consideration, and wherever possible the change should be made within the organization.

It is thus high time that more attention was given to the whole question of retirement and its implications in our changing population structure. It is not sufficient for industry generally to follow the example which has already been set by the Post Office and by Mr. Butler in the Civil Service; nor can we be content to continue or to extend the work already being carried out by the Nuffield Research Unit. What is wrong with our present arrangements is, as Mr. W. A. B. Hopkins, of the National Institute of Economic and Social Research, pointed out in a recent article on "The Economics of an Ageing Population" (*Lloyds Bank Review*, January 1953), not that the pension is conditional on retirement, but that retirement with a pension is available, and often compulsory, to people very many of whom would be quite capable of staying at work for some time longer. As already seen, in recent years a good deal of evidence has accumulated to show that it is rather the exception than the rule for a man to be genuinely past work at sixty-five.

Even if there were no adverse demographic tendency to combat, it would be sensible to try to alter the arrangements which cause waste of productive economic resources; but the first and most essential step, Mr. Hopkins argues, is to eliminate from the national insurance system the commitment to provide a retirement pension at a definite age laid down years, or even decades, in advance. Mr. Hopkins recognizes that the presentation of the scheme to the public in the past has been such as to cause false impressions and to create expectations which may well lead to resentment when a government is compelled, as he believes is inevitable, to raise the pension age. Nevertheless, he believes it is necessary that the principle should be publicly established that the age at which retirement pension may be claimed is variable, and will probably be raised as time goes on. As he admits, a government which made such an announcement would obtain no immediate credit, and would probably incur some immediate odium. It would, however, earn the gratitude of its successors by establishing the conditions in which pension arrangements could eventually be adjusted to changes in the demographic and economic circumstances of the country. No political party has, however, yet given any signs of the courage demanded in taking such a step; and it is therefore the more important that private as well as public industry should follow the example already set by government departments and at least experiment in this direction.

Such experiments in themselves encourage the development of a climate of opinion favourable to the pronouncement for which Mr. Hopkins calls. It should be recognized, however, that for a policy of later retirement to act fairly and effectively, uncertainty must be removed so far as possible. Save where it depends on experimental work such as the Nuffield Research Unit is conducting, the experimental period should be short. This point was well put by the Master of Sydney Sussex College, Cambridge, Mr. Thomas Knox-Shaw, in discussing the question of university retirement in the *Universities Quarterly* of August 1952. Compulsory retirement in a university at sixty-five, he thought, is often wasteful as well as painful; but while clearly time is required to explore the different possibilities and alternatives to which he points, it is essential to terminate as early as possible the uncertainties which such discussions are bound to raise in the minds of those immediately affected. The question of retiring age is undoubtedly one which requires urgent and full discussion, not only by the universities but also by professional bodies generally as well as by industry. Such discussion, even more than unilateral action, can promote the formation of the public understanding which is so essential. That it should be regarded as a matter of urgency is dictated both by individual and the national interest.

CHEMISTRY'S DEBT TO RADIOACTIVITY

Radioactivity applied to Chemistry

Arthur C. Wahl (editor), Norman A. Bonner (associate editor). Pp. xv+604. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1951.) 60*s*. net.

ALTHOUGH it is not yet sixty years since Henri Becquerel discovered the uranium rays, the rapid growth of the science of radioactivity has completely changed physics, profoundly influenced chemistry, and provided biology and medicine with new methods. It has become more and more difficult to keep pace with the radioactive studies even in one of these fields, and many chemists will be very glad that, so far as their science is concerned, an extremely useful survey of the literature up to 1950 is now available.

Twelve men of science have collaborated in producing a stately volume of six hundred pages, but the presentation of the subject could not be more consistent if it had been the work of a single author —a sign of the great care exercised by the editors in co-ordinating the work of the contributors. As the title of the book indicates, it was not their aim to deal with all aspects of radioactivity which might well be of interest to the chemists, but only with its application to the solution of chemical problems. 'Radiation chemistry' is only very briefly dealt with, and some branches of 'radiochemistry' are not mentioned. No reference is made to radiochemical techniques, or to the preparation of tagged compounds; but within the self-imposed limits the editors have aimed at completeness, and it seems that they have very well achieved their goal. Even recondite references of small importance have been found to be included. In Part 1 of the book—some three hundred pages—the usefulness of radioactive indicators is shown by a description of their application to a great variety of chemical problems; it will be found very useful by all interested in the subjects mentioned but not acquainted with the

radioactive method of their investigation. About two hundred pages of Part 2 give a summary of the relevant literature, and the rest contains the bibliography and the index.

In the preface the principal editor states that the contributors to this book became interested in the application of radioactivity to chemistry only during the Second World War, that they were then unfamiliar with most of the earlier work, and that the book is the outcome of their effort to correct this situation. It is therefore not astonishing that, in spite of the thoroughness of their search through the literature, they did not always gain the historical perspective which would come naturally to authors who were contemporaries of the earlier radiochemical investigations. Sometimes one would have preferred a different grouping. For example, in the days when no bismuth hydride was known, its discovery by the use of a radioactive isotope was interesting as a contribution by a new method to preparative inorganic chemistry, but scarcely as an example of "evaporation from solution", the heading under which it is here classified. A strange historical slip could not have happened to a veteran in the field; it is stated that neon, krypton, xenon, europium, lutetium, hafnium and rhenium were found in the period 1898–1925 by the method of X-ray spectroscopy; but Moseley's fundamental work on which X-ray spectroscopy is based was done only in 1913, and even after that date its application to the discovery of inert gases can scarcely be imagined. Hafnium and rhenium are the only examples where X-ray spectroscopy was used; for the discovery of the other five elements, the old-fashioned optical spectroscopy was decisive.

This point, however, concerns only the history of chemistry and is entirely unconnected with the main contents of the book, which is outstanding in its reliability. It is easy to predict that the book will become an indispensable standard work in all laboratories interested in radiochemical work.

F. A. Paneth

ORTHOPTEROID INSECTS OF FRANCE

Faune de France

56: Orthoptéroïdes. Par Prof. Lucien Chopard. (Fédération Française des Sociétés de Sciences naturelles: Office central de Faunistique.) Pp. 359. (Paris: Paul Lechevalier, 1951.) n.p.

THIS work by Prof. L. Chopard is more than a mere revision of the third volume ("Orthoptères et Dermaptères" by the same author, published 1922) of this well-known series: it has been expanded to include more detailed information and covers a wider field. Under the heading "Orthoptéroïdes", Prof. Chopard includes Orthoptera (s. str.), Dictyoptera, Isoptera, Cheleutoptera, Dermaptera, Embioptera and Plecoptera. The last of these groups (all of which the author, in accordance with modern views, regards as orders) has been treated separately by R. Despax in Vol. 55 of the series. The present volume is a guide to the identification of the French representatives of the remaining orders, and includes all information, both systematic and biological, which is likely to be useful for this purpose.

The work is arranged on the same plan as the other "Faune de France" volumes, with concise determination keys leading to brief descriptions. An important improvement on the earlier edition is the inclusion of numerous drawings of whole insects (about one per genus); among these are a number of figures of immature stages. Most of the remaining drawings serve to illustrate many of the finer distinctions used in the determination keys. They are reproduced from Vol. 3 of the series and are rather less accurate than those drawn specially for the present volume. Altogether there are more than five hundred figures.

The text is on the whole up to the usual high standard of this well-known authority; but it is difficult to accept some of the extreme measures taken in the classification of some of the groups. For example, no fewer than sixteen Saltatorian groups generally regarded as subfamilies have been given family status, thus doubling the number of families ascribed to the Saltatoria by other recent workers. Although the formation of new families will be inevitable as the groups become better known, it would perhaps be wiser to adopt a rather more cautious attitude until greater attention has been given to studies on their comparative morphology and anatomy.

The biological notes given with the more common species are largely new and have very much increased the value of the book. In particular, the descriptions of the 'songs' of many of the species will be found very useful in confirming their identity. Ample references are given to the work of other authors on the biology of a number of the species.

It is clear that in recent years much progress has been made in the study of European Orthoptera. Since the earlier volume of 1922 there have been some twenty additions to the French list, and some of these have been newly described species. There have been considerable advances in the study of their biology and distribution, and in many cases the time is ripe for the application of the polytypic species concept. In presenting with the utmost clarity much of this new and varied information in a single volume, Prof. Chopard has met a real need by workers on the European fauna, and his book is likely to stimulate further interest in a group of insects which has hitherto been denied its fair share of attention.

David R. Ragge

PREVENTION OF TUBERCULOSIS

Causes and Prevention of Tuberculosis

By Dr. Brice R. Clarke; with a Chapter on Mass Miniature Radiography, by Joseph Ritchie. Pp. viii+288. (Edinburgh and London: E. and S. Livingstone, Ltd., 1952.) 32*s*. 6*d*. net.

DURING the past quarter of a century, remarkable changes have occurred in the general outlook on nearly every aspect of the tuberculosis problem. Twenty-five years ago views on the pathogenesis of pulmonary tuberculosis were dominated by the theories of European pathologists. Ranke's three stages of the tuberculous infection, comparable with the three stages of syphilis, were commonly accepted, at least as a useful way of thinking. Childhood infection was, in most countries, almost universal, and was accepted by many as inevitable. In these circumstances, environmental and nutritional factors assumed an over-riding importance in the development of tuberculosis; and the most profitable

method of preventing the disease seemed to be the encouragement of the general level of resistance to infection among the population. The prevention of massive infection was acknowledged to be important, but, in general, measures directed towards improved social and economic conditions seemed likely to be more immediately rewarding in their results than any possible attempt at the elimination of infection. The clinical application of vaccination by BCG was only just starting to be investigated on a considerable scale. In treatment of individual cases of the disease, rest and general hygienic measures were the only generally applicable methods. These were supplemented in suitable cases of pulmonary disease by various forms of medical and surgical collapse treatment, and in other forms of disease by surgical removal of diseased organs or operations designed to immobilize affected structures.

To-day in many countries a steadily diminishing incidence of childhood infection has led to more frequent primary infections of adolescents and young adults. The immediate effects of such infections are, on a statistical scale, different from those which follow childhood infection, progressive disease of the lungs following as an immediate sequel very much more frequently. Consequently, again on a statistical scale, the pathogenesis of pulmonary tuberculosis in the young adult has changed. In prevention, it follows that methods aimed at the avoidance of infection are more immediately rewarding than in the past, and the dangers to the adolescent and young adult of contact with open disease are more obvious. In treatment, the development of effective antibacterial drugs has revolutionized the position and, hand in hand with technical advances in surgery, has made possible forms of treatment which in combination may be so effective that for some patients they might almost warrant the description 'curative', a term which, in the past, no one has been bold enough to use in connexion with this disease. It is relevant to remark, however, that these recent developments in treatment have had a paradoxical effect on the demand for hospital accommodation and trained staff. Whereas the introduction of the sulphonamide drugs and of penicillin has resulted in a much smaller demand for hospital beds for the treatment of acute infections such as pneumonia, the treatment of tuberculosis by modern methods remains a lengthy affair, needing the co-operation of larger numbers of highly trained medical and ancillary workers than were necessary for the simpler methods of treatment available in the past. The problems of minimizing the economic effects of this long-continued disease upon the patient and his family, and of his rehabilitation to as normal a life as is possible for him at the end of his treatment, remain unchanged.

Dr. Brice Clarke's book discusses these problems, especially as they are related to the design and administration of tuberculosis services. It attempts to cover the vast field in a way that will be helpful to those working in these services, including in short compass not only the epidemiological aspects which are dealt with by McDougall's "Tuberculosis, a Global Study", but also, though less completely, the field of pathogenesis covered by A. R. Rich's monograph. Some aspects are of necessity dealt with rather briefly, and, in particular, the section dealing with bacteriology is so sketchy that it is difficult to decide for whom it is intended; but adequate bibliographies at the end of each chapter minimize such deficiencies. There are some *ex cathedra* statements with which not everyone will agree. Many of the tables and graphs are not provided with legends adequate to make them self-explanatory, and in any future edition this defect could well be remedied. On the whole, this is an adequate and useful summary of much work in the several fields of study relevant to the problems of those engaged in tuberculosis and public health services. J. G. Scadding

THE EXTRA PHARMACOPŒIA (MARTINDALE)

The Extra Pharmacopœia (Martindale), incorporating Squire's Companion

Twenty-third edition. Vol. 1. Pp. xxii+1352. (London: Pharmaceutical Press, 1952.) 55*s*.

THE "Extra Pharmacopœia (Martindale)" has for long been the best book of reference for those who require quick access to the essential facts about medicines. The first edition appeared in 1883 and was followed by twenty-one more editions during the next sixty years. Publication was interrupted by the Second World War, and the world has had to wait eleven years for the twenty-third edition. Vol. 1, which has now appeared, is complete in itself and gives an account of practically all the drugs available in Great Britain and many foreign drugs as well. It contains more than a million words and looks like its immediate predecessor; but it is slightly larger in all dimensions and weighs about 40 per cent more. It incorporates an old rival in the form of "Squire's Companion to the British Pharmacopœia". This new edition includes four thousand abstracts, nearly three-quarters of which are from the past ten years, and a therapeutic index giving references to the medicines used in about seven hundred and fifty forms of illness.

Never has therapeutics advanced so rapidly as during the past ten years, and the editors are to be warmly congratulated on the way they have brought this book up to date. The official name of each drug is followed by its chemical name, molecular weight and trade names. Physical properties, such as solubility and stability, are briefly summarized. The dose is given and there are sections on toxic effects, antidotes, contra-indications and uses. The numerous abstracts give a clear idea of the value of the evidence about the effects of the different drugs in practical medicine. There are, for example, about forty abstracts on methonium compounds which give a clear picture of the rather uncertain state of our knowledge about them. Up-to-date information of this kind is given about all the latest drugs, the names of which are too numerous to mention. It has not been possible to give a list in the preface of all the new substances included, but a select list of about a hundred and fifty of them looks most impressive. Special sections are devoted to antibiotics (ninety-nine pages), immunological products (fifty pages), blood transfusion (thirty-one pages), ligatures and legislation.

This great work has been produced under the editorship of T. C. Denston, followed by K. R. Capper, with half a dozen assistants and a few expert advisers—S. L. Ward has been associated with this book since 1923. It is wonderful that so much has been done so well by so few. J. H. Gaddum

INTERNATIONAL SCIENTIFIC RADIO UNION

MEETING IN SYDNEY

THE tenth general assembly of the International Scientific Radio Union (U.R.S.I.) was held in Sydney during August 11–21, 1952, followed by a visit, reception by the Commonwealth of Australia Government, and closing ceremonies at Canberra during August 22–23. This was followed by a two-day meeting of the Mixed Commission on the Ionosphere, also in Canberra, at which matters of common interest to the Union and the corresponding International Astronomical and Geophysical Unions were discussed. The proceedings of this Mixed Commission will be reported separately. Furthermore, advantage was taken of the presence of a number of British radio scientists to hold a meeting in Sydney of the Commonwealth Specialist Conference on Radio Research.

The assembly of the International Scientific Radio Union was attended by some seventy delegates representing fourteen countries, and by a large number of Australian scientific workers and engineers who, as observers, were interested in being present at the first meeting of an international scientific union to be held in Australia. The general organization of the work of the Union under seven Commissions, and the constitution of the British delegation have been given previously[1]. This article presents a general description of the Sydney meeting and a summary of the proceedings of the various Commissions.

Measurements and Standards

The president of Commission 1 of the Union, Dr. J. H. Dellinger (United States), made an introductory statement on the progress of international work in the field of standards and measurements, and this was followed by two sessions of the Commission: the first on frequency and impedance measurement, under the chairmanship of Prof. M. Boella (Italy); and the second on power and special receiver measurements, under Dr. R. L. Smith-Rose (Great Britain). Twenty-eight papers, of which eleven were reports from national committees, were available and were considered according to the subject-matters of these sessions. Of great interest was a paper by C. J. Grebenkemper and J. P. Hagen (United States) which described the results of measurements on resonant cavities at very low temperatures, 1–3° K., in an investigation of superconductivity in metals at microwave frequencies. For a tin-plated resonator, the Q-value increased from 5×10^4 to more than 10^6 as the temperature was reduced to the values mentioned. A discussion took place on the use of this technique for studying skin-effect in different metals, and on the influence of surface finish on the results.

Several papers dealt with various aspects of measuring power at ultra-high frequencies. These included a description by A. L. Cullen (Great Britain) of the radiation pressure method of measuring 10–60 W. at wave-lengths of 3 and 9 cm., and an account of a micro-calorimeter by A. C. Macpherson (United States) for the absolute measurement of a power of 1–15 mW. at a wave-length of 9 cm. A novel method of calibrating field-strength measuring equipment was described by H. E. Dinger and W. E. Garner (United States), in which the calibrating voltage from a signal generator is applied across the gap in the shield surrounding the loop antenna.

At the close of its work, Commission 1 confirmed its previous resolutions concerning the study of reception of standard-frequency transmissions and time signals, and the international comparison of methods of measuring power at radio frequencies. Also, mainly as a result of a paper by Dr. L. Essen (Great Britain), the following resolution was put forward and adopted by the general assembly of the Union: "As a result of investigations made in recent years by several different methods, it is recommended that the following value of the velocity of electromagnetic waves in vacuum be adopted for all scientific work: 299,792 ± 2 km./sec.".

Troposphere and Wave Propagation

Under the presidency of Dr. C. R. Burrows, Commission 2 held four meetings at which some fifty papers and reports were discussed, dealing principally with the subjects of very-short-wave propagation both over optical paths and to distances beyond the horizon, and with the influence of meteorological conditions on this propagation. Particular note was taken of the requests made at the Geneva meeting (1951) of the International Radio Consultative Committee (C.C.I.R.) for co-operation in the study of tropospheric wave propagation in view of the importance of short radio waves (all wave-lengths less than 10 m.) in the development of broadcasting, television and communications generally. Results of the observation of fading on centimetre wave-lengths made in New Zealand, Sweden and the United States for distances up to about 100 km. were described and discussed, and it was generally agreed that it is difficult in many cases to explain the depth of fading in terms of the variations of the refractive index modulus over the whole path. Dr. J. B. Smyth (United States) emphasized the need for obtaining and studying micro-meteorological data, and claimed that in this way the main characteristics of radio-wave propagation over distances up to more than 100 km. could be predicted with a considerable measure of agreement with the experimental results.

Among the resolutions adopted by this Commission were recommendations that the scattering of radio waves by fluctuations in the lower atmosphere should be studied in different countries, with particular reference to the dependence of this scattering on latitude, climate and terrain. The statistical characteristics of fluctuations in atmospheric refractive index should also be explored, making use of recent developments in micro-meteorological measuring technique. In addition, it was recommended that at all frequencies above 30 Mc./s. research should be directed towards establishing a better understanding of the correlation between readily available synoptic meteorological data and radio propagation characteristics. While the Union takes all possible steps to ensure that national meteorological authorities are aware of the need of radio scientists for aerological observations, it has specially asked the Joint Com-

mission of the International Geophysical Year (1957–58) to take into consideration the needs of radio meteorology when planning its programme of meteorological measurements.

Ionosphere and Wave Propagation

Sir Edward Appleton presided over the sessions of Commission 3, which had about one hundred documents before it relating to various aspects of research on the ionosphere and the propagation of waves over a wide range of frequencies. A discussion on "Movements in the Ionosphere" was opened by Dr. G. H. Munro (Australia), followed by Dr. W. J. G. Beynon and Profs. L. G. H. Huxley and L. Manning among other speakers. It was clear that there is considerable interest in the study by radio methods of regular and irregular movements in the ionosphere. Knowledge of these movements is rapidly accumulating and is of great interest from the point of view of upper-atmospheric meteorology.

One of the most interesting topics discussed concerned the effective conductivity of the atmosphere. At the second session of the Commission, papers were presented by Drs. W. G. Baker and D. F. Martyn (Australia)[2], with additional contributions by Prof. T. G. Cowling and K. Hirono, all of whom showed how, in spite of the presence of the earth's magnetic field, the conductivity could reach a magnitude of the order required in the theory of geomagnetism. This was followed by a discussion on "Ionospheric Storm Phenomena", opened by Dr. Martyn[3] and continued by Sir Edward Appleton and others. This subject is of considerable interest not only to scientific workers interested in relating ionospheric disturbances to other geophysical phenomena, but also to the radio engineers who are seeking reliable forecasts on the progress of ionospheric storms around the world, so that they may anticipate the considerable interruption of communication circuits which accompanies such storms.

Considerable interest was also aroused in a discussion, opened by J. C. W. Scott (Canada), on the propagation of very-high-frequency radio waves over distances of the order of 1,000–1,500 km., by way of scattered reflexions in the ionosphere. The relationship between scattering at normal and at grazing incidence was emphasized, and it was pointed out that, for frequencies exceeding the normal maximum usable frequency, the reflexion coefficient may be determined by a very thin layer rather than by a general increase in ionization. Reference was made to the observations taken in Great Britain, Australia, New Zealand and the United States on the scattering of very-high-frequency radio waves due to the incidence of meteors in the ionosphere. It appears that meteor showers add to a fairly constant level of meteoric activity which is always present at a height of about 110 km., the diurnal variation resulting from such showers being much more marked in the winter than in the summer months, at any rate in the southern hemisphere.

A discussion on wave-interaction was opened by Mr. R. A. Smith (Australia), deputizing for Prof. V. A. Bailey, who was prevented by illness from being present, and was continued by Dr. M. Cutolo (Italy), Prof. L. G. H. Huxley (Australia) and Mr. J. A. Ratcliffe (Great Britain). This was followed by a presentation by Dr. R. A. Helliwell (United States) of some papers dealing with an investigation of the characteristics of the ionosphere at a frequency of 150 kc./s. and the corresponding propagation of low-frequency waves. Some of this work was concerned with a study of turbulence in the lower region of the ionosphere and with stratification in the sporadic-*E* layer.

The following resolutions were formulated as a result of the deliberations of Commission 3: a world-wide study of movements in the ionosphere should be made; attention should be given to the method of measuring ionospheric absorption using galactic noise signals; attention should be given to the study of auroræ by the radio-echo method and to the effects of auroræ on galactic noise radiations; there should be an extended study of the development and morphology of ionospheric storms; and experiments should be made in all parts of the world on the propagation of very-high-frequency waves by ionospheric scattering.

International Geophysical Year

In 1950 the Mixed Commission on the Ionosphere put forward a proposal for a Third International Polar Year to be held during 1957–58, the previous Polar Years having been held during 1882 and 1932–33. Subsequent discussion had made it clear that the former emphasis on the polar nature of the project would need modification, since observations in tropical latitudes are now also of great interest. Accordingly, it has been agreed to change the title to "International Geophysical Year 1957–58"; and during the Sydney meeting the International Scientific Union established its own committee, under the chairmanship of Sir Edward Appleton, to advise on all aspects of radio work during this year. The Union also suggested that each country should establish a Geophysical Year Committee.

In connexion with proposals made for a new world determination of longitude during the Geophysical Year, a sub-commission of the Union, under the chairmanship of Prof. M. Boella, was appointed to study the propagation time of radio signals over long distances, and to collaborate with the International Union of Geodesy and Geophysics and with the International Astronomical Union.

Terrestrial Atmospherics

In the absence of Prof. H. Norinder (Sweden) the meetings of Commission 4 were presided over by Mr. J. A. Ratcliffe (Great Britain) and were chiefly devoted to discussions on the wave-forms and mean level of atmospherics, and on the characteristics from which the interference to different types of communication system can be determined. On the first subject, Dr. R. Rivault (France) pointed out that the wave-form of atmospherics received over the same distances depend to some extent upon the geographical location of the lightning strokes from which they arise. Mr. Ratcliffe gave an account of recent work on 'whistling atmospherics' and of a tentative theoretical explanation of these. Dr. R. A. Helliwell (United States) said he had recorded such 'whistlers' simultaneously at two places about 1,500 km. apart.

On the measurement of the general level of atmospheric noise, the meeting agreed with the recommendation by the International Radio Consultative Committee to continue to use the subjective method of measurement due to H. A. Thomas until an objective method is in use and is found to be satisfactory. In this connexion, it was opportune that Mr. H. E. Dinger (United States) described the American plans for a world-wide measurement of

atmospheric noise by an objective method at some fifty stations to be installed during the next two years. In the meantime, it was urged by the chairman that measurements in the high-frequency range by the subjective method should be resumed in Australia and New Zealand; and attention was directed to the British plans to extend the world survey to lower frequencies. Mr. F. F. Gardner (Australia) gave an account of noise measurements made on a frequency of 2 Mc./s. at a place remote from sources of man-made interference. He said that by day the only noise measured was that corresponding to the thermal noise from the ionosphere, while at night the prevailing noise arose from man-made sources in a city 50 km. away. Mr. Dinger stated that at high latitudes noise due to precipitation is very important and can interrupt traffic for several hours on frequencies between 18 kc./s. and 18 Mc./s. In addition, interference is often associated with storm clouds even when there is no actual precipitation.

Concerning the future, it was agreed that at the next general assembly of the Union discussions would be held on the following topics: wave-forms and propagation of atmospherics; meteorological aspects of atmospherics; world-wide 'noise surveys'; and atmospherics as a source of interference to communication systems.

National committees were asked to encourage research in these subjects, and in particular to endeavour to provide an answer to the following question posed by the International Radio Consultative Committee: "What are the most easily measured characteristics of terrestrial radio noise from which the interference to different types of communication system can be determined?" Finally, the Commission recommended that, during the International Geophysical Year, three lines of work should be undertaken: measurements, of a high standard, of the radio noise at as many places as possible, including the polar and auroral regions; observations of the wave-forms of atmospherics, including 'whistlers', at several places, including the equatorial and polar regions; and optimum use to be made of organizations set up for the location of thunderstorms and lightning flashes.

Radio Astronomy

Commission 5 formerly defined its scope by the title "Extra-terrestrial Radio Noise"; but at the general assembly in Zurich during 1950 it was renamed as the Commission on Radio Astronomy, and its scope was extended to include such subjects as meteors and the moon when observed by radio techniques, as well as the investigation of radio emissions from the sun and stars. The meetings of this Commission in Sydney were of particular interest in view of the large amount of research in this field which has been conducted in Australia during the past few years under the auspices of the Commonwealth Scientific and Industrial Research Organization. The visit of the Union provided a most valuable opportunity for the research workers in this field in the northern and southern hemispheres to discuss their experiences and results.

At the first of four sessions, Mr. W. N. Christiansen (Australia) described observations of solar radiation made on a wave-length of 21 cm. (frequency 1,420 Mc./s.) using a linear array of thirty-two parabolic reflector aerials along an east–west line some 240 m. long. The radiation diagram of this system comprised lobes 3′-arc wide and 1·5° apart; and a continuous record was obtained as the sun passed through several lobes. The observations showed the presence of disturbed areas on the sun, closely associated with sunspots and persisting for one or two revolutions of the sun. The distribution of radiation across the disk was deduced: this showed limb-brightening corresponding to a coronal temperature of $2{\cdot}5 \times 10^6$ °K. Dr. J. L. Steinberg (France) reported observations made on solar eclipses on wave-lengths of 178 m. and 3 cm., and these could only be explained on the assumption that the solar corona was not circularly symmetrical. These results were confirmed by other observers on various frequencies between 225 and 10,000 Mc./s., and in most cases there was evidence of limb brightness. Dr. F. G. Smith (Great Britain) described interferometric measurements of the distribution of brightness across the sun on four wave-lengths between 60 cm. and 7·9 m. in an attempt to determine the distribution of temperature in the corona. It was shown that no simple model of the solar atmosphere can explain results on these wave-lengths, it being difficult to interpret the observed radiation from regions at two or three times the solar radius from the centre of the disk.

At the second session, which, like the first, was presided over by Dr. D. F. Martyn, a discussion on the dynamics of ionized media was opened by Prof. H. S. W. Massey (Great Britain), followed by contributions by Dr. Martyn, by Drs. K. C. Westfold and J. H. Piddington (Australia) and by Dr. N. Herlofson (Sweden). Some of the particular problems considered were the nature of modes in a plasma and the setting-up of oscillations with consequent radiation from plasma. It was shown that reflexion from dense meteor trails when the electric vector is not along the trail is not fully understood.

The subject of the third session was interstellar gas, and at this meeting Dr. H. I. Ewen (United States) described his work on the reception of the line radiation at 1,420 Mc./s. originating in the neutral hydrogen atoms in the galaxy. The frequency and intensity of the line were shown in the early experiments to depend on the direction of the observation. Mr. Christiansen and Dr. C. A. Muller (Netherlands) described their investigations of the variations of frequency and of the deductions which could be made about the movements of the emitting portions of the galaxy.

At the last session, Dr. B. Y. Mills (Australia) surveyed the techniques which have been used for the observation of discrete sources of cosmic radio waves. Observations made in Sydney on a frequency of 100 Mc./s. show that the more intense radio stars are concentrated towards the galactic plane. R. Hanbury Brown (Great Britain) reported results obtained on a frequency of 160 Mc./s., in which a source was discovered near the position of the supernova observed by Tycho Brahe; other sources were tentatively identified with clusters of extra-galactic nebulæ. Dr. J. G. Bolton (Australia) described an extension of the sea interferometer experiments, and a new instrument for determining azimuth. He has been able to show that the angular diameter of some radio stars can be resolved.

Among the thirty-three documents distributed to this commission were several reports from national committees which present useful surveys of the very rapid progress made in recent years in this general field of radio astronomy.

Waves, Circuits and Electronics

The interests of Commission 6 are considered to cover such fields as theory of information; theory of non-linear oscillations; linear circuit theory; and diffraction theory, antennæ and wave-guides. Various working parties were set up at Sydney to report on progress in these fields, and national committees were recommended to give serious consideration to a number of matters relevant to the theory of information and its practical application to communication matters in which the International Radio Consultative Committee had expressed particular interest.

Three sessions of the Commission concerned with electronics were held, at the first of which new developments in vacuum tubes were discussed, while the second dealt with such subjects as the dielectric properties of solids, the thermionic constants of metals and the electrical properties of thin films. The final session dealt with the fundamentals of gas discharges, the interaction of electromagnetic waves with plasma, and the radiation of micro-wave noise from gas discharges.

Publications

Hitherto the proceedings of the General Assemblies of the Union have been published with the detailed texts of all documents. On the present occasion, the executive committee of the Union decided to discontinue the publication of the individual papers, which are either incomplete summaries of the papers presented at the sessions or are papers which are or will be published in the recognized scientific journals. A more useful objective to be pursued is to publish additional special reports on selected radio topics, and to make these universally available. Two such reports have already been published, one on "Solar and Galactic Radio Noise" and the other on "Tidal Phenomena in the Ionosphere"; and a third, on "The Dynamics of Ionised Media", is in the press. Among the subjects proposed for future reports are ionospheric storms, radio investigation of meteors, ionospheric wave interaction, interstellar hydrogen, discrete sources, and the distribution of radio brightness on the solar disk.

Officers

At the closing meeting of the general assembly, the following officers were elected: *Honorary presidents*, Sir Edward Appleton, Dr. J. H. Dellinger and Dr. B. van der Pol; *President*, Father P. Lejay; *Vice-Presidents*, Dr. C. R. Burrows, Dr. D. F. Martyn and Prof. B. D. H. Tellegen; *Treasurer*, Prof. C. Manneback; *Secretary General*, Col. E. Herbays; and *Chairmen of Commissions*, (1) Dr. R. L. Smith-Rose, (2) Dr. C. R. Burrows, (3) Sir Edward Appleton, (4) Mr. J. A. Ratcliffe, (5) Dr. M. Laffineur, (6) Dr. L. C. von Atta, and (7) Prof. G. A. Woonton. Delegates of the Union were also appointed to serve on various other international organizations.

In addition to the scientific meetings described above, the delegates participated in an extensive programme of technical visits and social events which displayed both the intention and the ability of their Australian hosts to make the occasion as instructive and pleasant as possible. The University of Sydney, the National University at Canberra, the Commonwealth Observatory at Mt. Stromlo, the various laboratories and field stations of the radio and electrical divisions of the Commonwealth Scientific and Industrial Research Organization were all visited, as well as some of the laboratories and works of firms in the associated industry. On such occasions, chiefly at week-ends, when no formal business sessions were on the programme, all the delegates were provided with excellent opportunities for enjoying the beautiful scenery around Sydney and farther afield in New South Wales. The hospitality shown by the Commonwealth Government and by private organizations and individuals has left a memorable impression of this visit to the only continent which lies wholly in the southern hemisphere.

R. L. Smith-Rose

[1] *Nature*, **170**, 152 (1952).
[2] See *Nature*, **170**, 1090 (1952).
[3] See *Nature*, **171**, 14 (1953).

PLANKTON OF THE BENGUELA CURRENT

By Dr. T. J. HART
National Institute of Oceanography

DURING the two surveys of this area in 1950 that yielded the hydrological results described in a recent article by Currie[1], extensive plankton collections were made. Preliminary sorting of the zooplankton material is not yet complete—in addition to its being nearly as rich as that of polar waters in quantity, it is much more diverse in quality—and a greater expenditure of time than that required for this phase of the work on material from most other regions is therefore unavoidable. Moreover, the full value of the material can only be assessed when specialists working independently on the various groups have completed their reports. At this stage, therefore, only major features of group-distribution, rendered clear by the preliminary work on material from the first survey, have been considered.

With the phytoplankton we can already proceed much further. In dealing with it, a conservative choice of method was necessitated by practical considerations (to be stated in the main report), and our estimations for all stations on both surveys are now complete. These were made by Hensen methods from 100–0 m. hauls of the Gran net. When plotted logarithmically, they seem adequate to show up the grosser quantitative differences; for it was found that the concentrations of phytoplankton in this area were such that, whether dealing with important individual species, groups or grand totals, a 50 per cent alteration of values assigned to the contours in either direction made but little difference to their position on the chart. Moreover, scores of individual species, only one or two of which can be cited here, showed distributional patterns in good agreement with the hydrological features. The latter were, of course, quite independently assessed.

Close similarity to the conditions off Lower California in 1941, as described by Sargent and Walker[2], working from W. E. Allen's counts, is evident. They found a succession of three "plankton elements" in a large eddy of the upwelling current, with Chætocerids predominating in the richest, most recently upwelled and coldest water, and a sparse warm-water element offshore. This last, however, was in the oldest surface water from the eddy, not in a distinct, more oceanic,

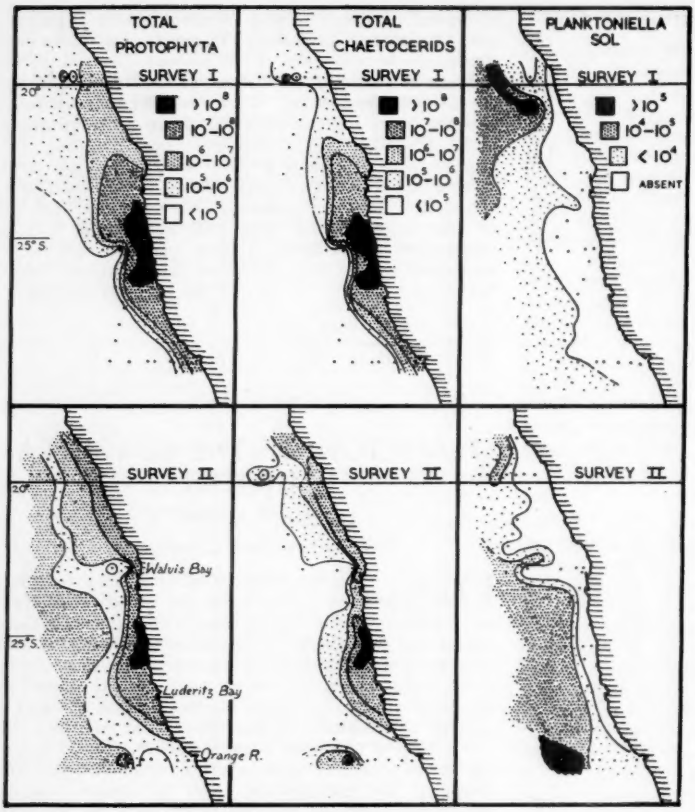

Fig. 1

body of surface water as here. It seems that in relatively narrow eddies set up in the Benguela Current, the whole circulation is more rapid, so that some 'ageing'—which involves heating—of the upwelled water must take place before peak phytoplankton production becomes possible. Even so, many of the cosmopolitan species we found so abundantly were present off California also, and though through lack of seasonal data we cannot generalize so far as Sargent and Walker have done, the close analogy between the two regions seems clear.

In the Benguela Current we found the rich catches concentrated on the shelf some 10–45 miles from the coast, in the central area from Luderitz Bay northwards, as shown to the left of Fig. 1. Species of *Chætoceros* were so far dominant that their distribution (centre) forms an essentially similar pattern. They formed 60–90 per cent of the catch at most of the richer stations. Currie's[1] computations show that upwelling activity is normally greatest in this area.

Higher average values, and restriction of the rich area to the northward combined with a greater extension of it seaward, were features distinguishing the autumn observations (first survey) from the spring ones (second survey). Together with some marked qualitative differences, it is these which suggest that the slackening of upwelling in autumn (demonstrable from the physical data) allowed peak development of the succession. The hypothesis that such a peak may not be attained locally when the whole circulatory complex is speeded up follows as a corollary from the spring observations; for there must be a time-lag before the diatoms seeding the rich water newly arrived within the photic zone can proliferate sufficiently.

Of the various species, *Chætoceros compressum*, *Ch. curvisetum* and *Ch. didymum* were most important, closely followed by several more (of the section Hyalochæte) of that difficult genus. *Asterionella japonica* was the most abundant pennate form able to flourish among them; but close inshore *Fragilaria karsteni* was more important. On the first survey *Eucampia zoodiacus* was quite numerous in the rich diatom zone; but on the second survey we saw none, though it was present farther south, and in colder water at that time. This may be an extreme example of the succession effect postulated above. Possibly a more directly seasonal effect was the great abundance of resting spores of *Chætoceros didymum* in autumn, and a great scarcity of them in spring (though plenty of the normal vegetative phases were present).

The sparse phytoplankton of the offshore surface water contained relatively large numbers of *Planktoniella sol*. This distribution is shown to the right of Fig. 1. It fits the intrusions of offshore water determined by physical and chemical means very closely. The most striking example is the tongue of *Planktoniella*—rich water from the north, projecting southwards and shorewards towards the colder *Chætoceros* zone during our first survey. Rayner (quoted by Gunther[3]) had found a similar relationship in the Peru Current, working from the same ship twenty years earlier. Clearly *Planktoniella* is a good indicator in such regions, provided that the phytoplankton is considered *in toto*.

Fig. 2 is partly a repetition emphasizing this point, but also showing another important feature. An isolated area with moderate quantities of Chætocerids can be seen to the north of the intrusion from offshore, probably a relic of previous continuous distribution; but in the area between the two strongly contrasting diatom floras, the Dinophycean *Goniaulax spinifera* predominated. The phytoplankton here was not rich, but it is noteworthy that this was the only area sampled during the survey, more than twenty miles offshore, where Dinophyceæ predominated over the diatoms. It is probably significant that here, where the distance between the two strongly contrasting types of surface water was least, one might expect lateral mixing between them to have been strongest.

On arrival at Walvis Bay during the first survey, we found that a fish mortality had occurred. Leaving

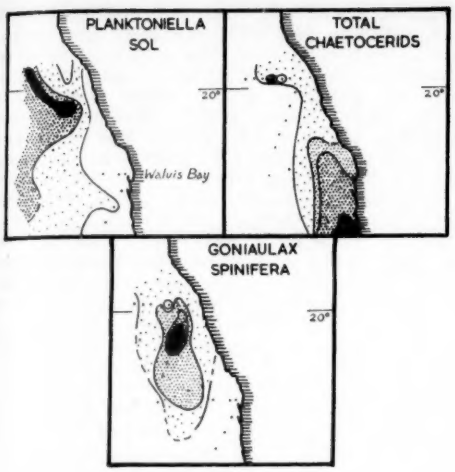

Fig. 2

next day on a south-west course we passed through large areas of discoloured water, some of them extending as far as fifteen miles seaward of Sandwich Harbour. Some of the more intensely coloured areas formed narrow bands with streaks of foam and Ctenophores disintegrating at the surface, like the wind lanes often formed in *Trichodesmium* blooms in warmer waters. Considerable congregations of sharks, sea-birds and seals were seen near by. They did not seem to be adversely affected. A series of surface samples was examined by centrifuge and drop method. *Gymnodinium* and *Goniaulax* spp. (two genera of Dinophyceæ already known to include 'lethal' species) were present, but only in very small numbers. Detailed counts of preserved material afterwards showed that a rich mixed plankton was present in the 'khaki' or 'olivaceous' areas. There were some half-million cells per litre: *Peridinium triquetrum* 39 per cent, the diatom *Asterionella japonica* 33 per cent, *Procentrum micans* 14 per cent, and most of the remainder quite large diatoms. Areas appearing more definitely brown or reddish at a distance showed *P. triquetrum* clearly dominant—more than 85 per cent of the numerical totals, which reached three to six million cells per litre. Equally heavy blooms of this very cosmopolitan, but usually more strictly neritic species, have been recorded from Scottish lochs and from inner Oslo Fjord, the latter in definitely polluted water (Marshall and Orr[5], Braarud[6]). Can it be that here this type of bloom follows rather than precedes mortalities? There is, however, one record associating this organism (under the name *Heterscapsa triquetra*) with a fish mortality at Rostock in the Baltic in 1917 (Lindemann, quoted by Brongersma-Sanders[4]). The Walvis Bay mortality had already occurred when we arrived there; but as we worked in towards the land by night, we do not know whether the bloom was already present offshore. However, it is now clear that water-blooms due to several quite different organisms may recur within this one sea area.

In some seas, blooms may be a direct cause of mortalities (as when caused by certain species of *Gymnodinium*, *Goniaulax* and other genera), but they are often quite harmless and not even coincident in point of time (*Prorocentrum*, *Amphidinium*). This is already clear from such work as that of Allen[7], Graham[8], and others. Thus Dr. Brongersma-Sanders's hypothesis[4], that mortalities near Walvis Bay are due to *Gymnodinium* poisoning, may prove quite justified, though none of the blooms I have yet been able to examine from the South African coast have belonged to that genus. We cannot yet say whether the relation between water-bloom and mortality here is causative, coincident or resultant. But we can say, from the evidence so admirably marshalled by Dr. Sanders, that bloom has often been seen at about the same time as a mortality.

For the present, Currie and I prefer to guess that the mortalities may be due to a combination of adverse factors, with oxygen shortage (below the extreme surface layer) perhaps the most important, the whole set in train by large-scale meteorological and hydrographic changes leading to slackening or temporary cessation of upwelling; the latter may involve incursions of warm surface water into the area from the north and west, though local heating must also figure largely under such conditions.

That the zooplankton of the Benguela Current is rich in quantity is obvious from the bulk appearance of the samples. Qualitatively it is much like that off Lower California and off Peru. Group sorting led to demonstration that considerable spawning of *Sardinops sagax* took place on the shelf, near the richest diatom area, early in March (Hart and Marshall[9]). Both economically and ecologically, this is the most important pelagic fish of the region. Post-larvæ reached a peak one station farther seaward than the egg-maximum on each line of stations, in accord with known water movement. Both eggs and young stages coincided with extraordinarily large catches of Cumacea in the plankton nets. Elsewhere, these mainly bottom-living crustaceans are usually subordinate to Mysidacea, except in some arctic localities. Their persistent presence here, in very large numbers, in the plankton, may have been due in part to oxygen deficiency in the lower water-layers. In March, Mysidacea predominated over the Cumacea at one station only—inshore off the Orange River.

While many cosmopolitan species abounded in the zooplankton, such as *Thalia democratica* and *Salpa fusiformis* among offshore Tunicates, and *Evadne nordmanni* among inshore Entomostraca, the important Euphausian species are more typically South Atlantic. Even so, Dr. Boden, who is now working up our Euphausians, and who has already studied Californian material, informs me that the distribution of genera and comparable species in the two areas seems most strikingly similar. The largest catches of Euphausians, especially the young stages, were taken with the richest phytoplankton (though not, of course, in the 'bloom' area) some 20–50 miles offshore.

The Ostracods from the first survey have already been reported on by W. J. Iles (in the press). They clearly formed an essentially mid-water, offshore group. Possibly their marked absence from stations over the continental shelf was due to the decrease in upwelling at that time. We already know that a few strayed farther in during the second survey.

Notable examples of group dominance were a great concentration of the Pteropod *Limacina bulimoides* offshore and near the shelf edge to the south, where we have some evidence that the phytoplankton had been heavily grazed. Large Aulacanthid radiolaria were very abundant offshore to the north, and *Acanthometron* at one shallow-water station to the south.

These examples are but a foretaste of the distributional data that we hope ultimately to extract from the material. The distribution charts I have included were redrawn for reproduction by Mr. Currie, to whom I am deeply grateful. Both of us are greatly indebted to the Director and staff of the Marine Biological Association's Plymouth Laboratory for providing unrivalled working facilities before the new premises of the National Institute of Oceanography were available.

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OBITUARIES

Prof. J. H. Orton, F.R.S.

James Herbert Orton, emeritus professor of zoology in the University of Liverpool, died on February 2, less than four years after his retirement from the Derby chair and the directorship of Port Erin Marine Biological Station.

Before going to Liverpool in 1929, Orton had spent nearly twenty years as naturalist (latterly, chief naturalist) at the Plymouth laboratory of the Marine Biological Association. Both at Plymouth and at Port Erin, Orton conducted vacation classes in marine biology and became known to large numbers of students, among whom his infectious enthusiasm proved a means of starting many on a career of marine biology.

During his tenure of the Liverpool chair of zoology, Orton was a popular figure with his students and the younger members of his staff. He did not, however, come into very close academic touch with his students, either by lecturing or otherwise, until their later honours or research years; but at this period they found him to be a wise guide and friendly counsellor in their studies. He was ever on the look-out for potential research workers in his chosen subject, and, having found them, never hesitated to demand from them the highest standards of technical ability and assiduity. These demands never went unheeded, for they never exceeded the standard he so obviously set for himself.

Though primarily a marine biologist, Orton was keenly alive to the importance of freshwater biology; he was an active member of the Dee Fishery Board, and had served on the Council of the Freshwater Biological Association. At Liverpool, he succeeded in establishing a lectureship in freshwater biology and an active school from which important studies in pollution problems and in the life-history of the salmon have issued.

In the marine sphere, Orton produced, over a period of forty years, a succession of papers, reports and notes covering a wide range; but it was upon the biology and economics of the marine mollusca that he became an acknowledged authority, whose opinion was sought by government departments and by commercial oyster-fishing interests alike. His papers on the biology of the 'native' or European flat oyster include studies of its growth, shell-formation, sex-change, food and feeding, environment, predators and culture-methods, and together form a corpus of knowledge for one species which has scarcely been equalled in the whole realm of zoology. His other molluscan papers include work on the cockle and the limpet, and on this latter he was engaged at the time of his death. The value of his researches was recognized, in 1948, by his election as a Fellow of the Royal Society.

Orton was appointed director of the Port Erin Marine Biological Station in 1939, ten years after his taking up the chair of zoology at Liverpool. The dual task, though a heavy one, was accepted gladly because it afforded him the opportunity of guiding the destinies of a marine station—a task for which his long experience at Plymouth had fitted him. At Port Erin, Orton was manifestly at his best—always eager and cheerful; but his well-laid plans for the establishment of 'Port Erin' as a first-rate centre of biological oceanography in the Irish Sea were delayed and partly frustrated by the onset of the Second World War, during which he took up active military service. After the War, limited expansion became possible, and this was greatly aided by the provision, from University funds aided by the Development Commission, of the M.V. *William Herdman*. Plans for structural changes in the buildings of the Port Erin station were also drawn up, but these have not yet been carried into effect.

The name of James Herbert Orton will remain honoured, at Port Erin as in his department at Liverpool, as that of a man who pursued his life-work with acknowledged success, tireless devotion and utter singleness of purpose. J. R. Bruce

Dr. A. N. Zavaritzky

Alexander Nikolaevich Zavaritzky, who died at his home in Moscow on July 23, 1952, was one of the most prominent petrologists in the U.S.S.R. He was born on March 14, 1884, in the town of Ufa, being educated at the gymnasium (grammar school) there, and then he graduated in 1909 from the St. Petersburg (now Leningrad) Mining Institute. In his capacity as lecturer in the Mining Institute, he assisted E. S. Fedorov and K. T. Bogdanovich in the work on petrology and ore deposits, and much of his subsequent scientific career was devoted to welding these two subjects together.

In 1921 Zavaritzky became a professor in the Mining Institute, but, as is usual in Russia, he combined teaching with a very active participation in the work of the official Geological Survey. At first he concentrated on the study of the magnetite ores of the Ural Mountains, especially on the ores of Mount Magnitnaya, which eventually played such an important part in the development of Soviet industry. The results of his research on the occurrence and modes of origin of these ores were published in a three-volume work in 1922–27. This work was followed by a number of publications, dealing with a great variety of subjects, among which may be singled out the ultrabasic rocks of the Urals, platinum deposits, alkaline rocks and pyrite deposits. In 1931, Zavaritzky began the exploration of the distant and difficult region of Kamchatka. He not only published valuable papers on Kamchatka's volcanoes but also organized an extensive survey of this region, and he eventually became the head of the newly established Volcanological Laboratory in Moscow and of its

branch in Kamchatka. He also studied the volcanic rocks of Armenia and Manchuria. From 1945, in collaboration with L. G. Kvasha, he began the reorganization of the extensive meteorite collections of the Soviet Union. He also published a number of papers dealing with minerals, microscopical methods and apparatus. In addition to several text-books, Zavaritzky published two important books dealing with the physico-chemical principles of the formation of igneous rocks (1926) and the petrochemistry of igneous rocks (1944). A general account of his scientific work has already appeared in *Nature* (**157**, 378; 1946), and a number of his works have been abstracted (*Min. Abstr. Min. Mag.*). A summary of recent work on the volcanoes of Kamchatka has been published in the *Bulletin Volcanologique* (Ser. 2, **8**, 87; 1949).

In 1939 Zavaritzky was elected a member of the Academy of Sciences and moved to Moscow, where he occupied a number of important scientific posts, combining administration, research, editorship and teaching. All his published work is characterized by a remarkable thoroughness and by lucidity of exposition. He was a first-class petrologist and an outstanding specialist on ore deposits. As a teacher, research worker and organizer, Zavaritzky will long be remembered in the U.S.S.R. and his death lamented by his numerous friends, colleagues and pupils.

S. I. Tomkeieff

Dr. J. A. Hewitt

The death on March 10 of Dr. James Arthur Hewitt robs preclinical circles in the University of London of a figure well known for more than thirty years. He was born in 1889, and after being at Glasgow High School and Hutcheson's Grammar School, he took a B.Sc. in St. Andrews in 1911, with special honours in chemistry, natural history and physiology. He became assistant to Prof. P. T. Herring and later senior assistant, acting as head during the prolonged absence of the professor.

On the outbreak of war in 1914, he joined the Royal Artillery, in which he had a very varied career, being attached at first to the Royal Flying Corps. Later he became a staff officer, Southern Command, specially concerned with anti-gas warfare. He was himself seriously gassed earlier, a fact which led to much subsequent ill-health.

On his return from service, Hewitt joined Prof. W. D. Halliburton at King's College, University of London, and collaborated with him in the first production of *Physiological Abstracts*, a landmark in medical literature. At first, he was a biochemist, obtaining his D.Sc. for researches in carbohydrate metabolism, but he was so extremely versatile that he was able at a later date to take over the teaching of histology from the late Dr. Da Fano. As a teacher he was superb, and he picked up new material easily. At one time, he even gave a course of advanced lectures on the nervous system before the work of Sherrington was so generally appreciated. His election to the chairmanship of the Board of Physiology of the University of London was eloquent of the appreciation of his personal qualities. This was the first time a non-medical man had been elected. He was elected F.R.S.E. in 1947.

He became increasingly popular with young people. While evacuated to Birmingham during 1941, he became a squadron-leader in the A.T.C., and on leaving was given a complimentary dinner. Many will remember, too, his enthusiasm for motor-cars, especially old crocks which he loved to take to pieces and get into working order. Only two years ago he took part in an important rally.

Hewitt will be remembered by his kindly way with students. As adviser to medical students at King's College, he was ever zealous in their interests, and many owe their careers to his insistence with difficult authorities. We all regret his passing.

R. J. S. McDowall

NEWS and VIEWS

Presidency of the Royal Aeronautical Society: Sir William Farren, C.B., F.R.S.

Sir William Farren has been elected president of the Royal Aeronautical Society for the year 1953–54 and will take office at the annual general meeting of the Society to be held on May 7. Sir William was born in Cambridge in 1892 and was educated there at the Perse School and afterwards in the University at Trinity College. After a short spell as an electrical engineer, he joined the Royal Aircraft Factory at Farnborough in 1915 and was in charge of the experimental and design aspects of aerodynamics there until the end of the First World War. From 1920 until 1937 he worked in university circles, being a lecturer at various times in engineering, aerodynamics and aircraft structures at Cambridge and at the Royal College of Science, London. Sir William then abandoned academic work and became deputy director of scientific research at the Air Ministry, rising to the post of director of technical development at the Ministry of Aircraft Production in 1940. The succeeding year he returned to Farnborough as director of the Royal Aircraft Establishment, and the five and a half years during which he held this post (in which he incidentally found the time to take up active flying again) were marked by a great increase in the staff, buildings, equipment and general activity in the Establishment. After the War, it was fitting that Sir William should decide to employ his energies in the aircraft industry, and since 1947 he has been technical director of A. V. Roe and Co., Ltd. His many achievements were acknowledged by his election to the Royal Society in 1945 and by a knighthood last year.

Royal Geographical Society: Awards

The Queen has approved the award by the Royal Geographical Society of Royal Medals as follows: *Founder's Medal*, Mr. P. D. Baird, director of the Montreal office of the Arctic Institute of North America, for explorations in the Canadian Arctic; *Patron's Medal*, Count Eigil Knuth, leader of the Danish Expedition to Peary Land in 1948–50, for explorations in northern Greenland and for contributions to Eskimo archæology.

The Council of the Society has made the following awards: *Victoria Medal*, Sir John Myres, emeritus professor of ancient history in the University of Oxford, for contributions to the geographical history of Greek lands and for his services to the development

of geography in education; *Murchison Grant*, Mr. G. B. Stigant, hydrographic department of the Admiralty, for studies and mapping of the Japanese coasts; *Back Grant*, Mr. G. de Q. Robin, senior British scientist on the Norwegian–British–Swedish Antarctic Expedition of 1949–52, for geophysical explorations in Queen Maud Land; *Cuthbert Peek Grant*, Mr. Duncan Carse, leader of the South Georgia (Antarctic) Expedition of 1952, for exploratory surveys and mapping; *Gill Memorial*, Mr. B. H. Farmer, Fellow of St. John's College, Cambridge, for studies of the use of land in Ceylon.

Secondary Technical Schools and Industry

In his presidential address on March 21 to the Association of Heads of Secondary Schools, Mr. H. B. Brown, headmaster of the Bordesley Green Technical School, Birmingham, referred to the development and present position of secondary technical schools, and pointed out that these schools demand of their pupils a very exacting standard of mental activity with an application tending to combine a comprehensive theory with sound practice. He suggested that industry could feel that the time a pupil spent in such a school after the normal school-leaving age is a real contribution to his or her training and might provide the background for later employment in administration, supervision or design. He recommended that training of a young person for a responsible post in industry or commerce should be regarded as divided between full-time school attendance, instruction within industry and special training, either in industry or in further-education establishments, the whole directed towards developing suitability for a position requiring special skills, aptitudes and responsibility. Mr. Brown looked for more co-operation between industry and the technical schools and expressed concern at the inadequacy of the present supply of teachers of science, applied science and crafts, a shortage which threatens the whole of the science and craft teaching in schools, and which may have repercussions on industry itself. He insisted on the need for technical schools to keep their methods of teaching and curricula, their relations with industry and the needs of the cultural world constantly under review and to anticipate and meet changing demands. It is a principal function of the Association, he maintained, to assist in co-ordinating the professional outlook of its members.

Investigation at Cambridge of the Feldspar Minerals

The Nuffield Foundation has offered a grant of £4,150 in aid of a research project on phase equilibrium relations and atomic structure of the feldspar group of minerals to be undertaken jointly by the Department of Mineralogy and Petrology and the Crystallographic Section of the Cavendish Laboratory at Cambridge. The application of recently developed techniques for feldspar synthesis under controlled conditions and for the rapid X-ray identification of crystalline phases, principally at the Geophysical Laboratory of the Carnegie Institution of Washington, has opened up a fruitful field of research of the first importance, not only for the understanding of the intimate relations within this great mineral group but also for the elucidation of the genetic history of feldspathic rocks, both igneous and metamorphic. The grant provided by the Nuffield Foundation will be utilized at Cambridge for the provision of equipment devised for the application of the new techniques in the investigation of the hydrothermal synthesis, polymorphism and unmixing relations of feldspar phases, and for fundamental crystal analysis studies, especially of synthetic feldspars of known thermal history.

Enzymic Systems in Root Apices

An account of a method for determining the development of the enzyme complement in growing root cells has been given by E. Robinson and R. Brown (*J. Exp. Bot.*, **3**, 9, 356; 1952). On corresponding successive segments from the root apex backwards, the water and protein contents and the activities of dipeptidase, glycine oxidase and invertase have been measured, together with the number of cells in each segment. From these data it has been possible to indicate how the quantities involved change during cell growth. Four phases can be distinguished in the early cellular development. During a cell's development in the meristematic region its volume increases slightly, the protein content probably decreases, and the activities of three of the enzymes studied decrease. During the second phase there is a large increase in cell volume and protein content, and all enzymic activities increase considerably. In the third phase, the cell increases in volume by increase in breadth, but its protein content and enzyme activities decrease. The fourth phase is marked by cessation of growth and a continued decrease in protein content and enzyme activity. In discussing their results, the authors point out that the enzyme activity varies directly with the protein level during all four phases, and that the enzymatic constituents account for, if not the whole, at least a considerable part of the total protein content. The possibility is considered that during cell growth there are changes in the composition and structure of the protein complex and that such changes are causally related to variation in the relative activities of the different enzymes. Whether cell growth is determined by changes in the protein contents and other related topics are discussed.

Stop-watches and Chronographs

Instruments capable of measuring and recording intervals of time to a fine degree of accuracy are required in many walks of life and particularly by the engineer and scientific worker in modern industry. Stop-watches and chronographs are mainly used; but few people understand the underlying mechanism, the degree of accuracy that can be expected and how to select the most suitable type for the work to be measured. The completely revised and reprinted catalogue of high-precision Swiss stop-watches and chronographs, recently issued by the firm of Camerer Cuss and Co. (54–6 New Oxford Street, London, W.C.1), which has specialized in horology since 1788, is, in spite of its small size, particularly valuable because it contains, in a preface, just those details which will assist the purchaser in the selection of the correct instrument. The function and action of the escapement is explained, how inaccuracies are reduced by proper choice of materials and arrangement is discussed, and the necessity is stressed for a periodical overhaul if a watch is to maintain a steady state. Where it is necessary to have a certificate of accuracy, the Metrology Division of the National Physical Laboratory, Teddington, will undertake an independent test. Watches required for the testing of electric meters are tested under the Electricity Supply (Meters) Act, 1936, to a specification issued by the Ministry of Fuel and Power. The instruments

illustrated and described in the catalogue are of various types, including three-pressure action, instantaneous fly-back and restart, and split-second stop-watches and chronographs with time of day and of the wrist pattern. All Camerer Cuss instruments contain the jewelled pallet-lever escapement, a superior pattern, and are jewelled in all the principal bearings.

Wave-lengths for Radial-Velocity Determinations of Stars

A PAPER on "Wave-Lengths for Radial-Velocity Determinations based on Measures of One Hundred F- to M-type Stars" has been published by K. O. Wright in *Publications of the Dominion Astrophysical Observatory, Victoria, B.C.* (**9**, No. 3, 167–180; 1952. Ottawa: Queen's Printer. 25 cents), which gives the results of the author's investigations begun in 1936 when he went first to the Dominion Astrophysical Observatory. Most of the plates that were measured had been previously taken for the absolute magnitude programme of Young and Harper, an account of which appeared previously in the *Publications* (**3**, 1; 1924), and were well exposed in the range 4000–4500 A. As many of these observations covered epochs not observed elsewhere, it was decided that the plates should be measured for radial velocities. Unfortunately, Wright's activities were transferred elsewhere when he had completed the measurement of about one-half of the plates; but the results obtained have proved very useful. One object of the measurement was to check the wave-lengths used in radial-velocity measurements of late-type stars, and preliminary velocities were derived by using Petrie's system of wave-length standards (described in *Contrib. Dom. Astrophys. Obs.*, No. 4, 1946). The results for each line have been averaged for each spectral type from *F*4 to *M*8 on the Young and Harper system (*Pub. Dom. Astrophys. Obs.*, **3**, 1; 1924), and the variation of velocity difference with spectral type has been the chief criterion in selecting the lines used in the investigation. The general results confirm that the "Lick Catalogue" (*Pub. Lick Obs.*, **18**; 1932) and the "New General Catalogue" (*Pub. Lick Obs.*, **16**; 1928) are, effectively, on the same scale and show that the velocities obtained are, on the average, 0·9 km./sec. more negative than the Mount Wilson velocities in the new catalogue. A list of nine stars is given of which the radial velocity may be variable, and only one of these has been previously announced by the Lick Observatory. The range of velocity in these stars is at least 8 km./sec., and, as an individual measurement should not be in error by more than 2 or 3 km./sec., it is considered probable that the variation in these stars is real.

Conference on Organic Evolution

THE National Institute of Sciences of India, encouraged by Dr. S. S. Bhatnagar, recently celebrated the presence in India of the distinguished German biologist, Prof. Bernhard Rensch, by organizing a conference on organic evolution at New Delhi during March 6–8. The programme and abstracts issued by the convener, Dr. Sunder Lal Hora, show that more than fifty papers were read and discussed, half of them being by non-Indian contributors. Four of the papers are by Prof. Rensch and his colleagues on problems of relative growth; four more are by eminent Western scientists, including the veteran French zoologist, Dr. Louis Fage (on subterranean evolution), and the American pioneer on fœtal behaviour, Dr. Lester W. Sontag; and eighteen are by leading British biologists, including Prof. J. D. Bernal, Dr. W. E. China, Prof. J. B. S. Haldane, Mrs. Haldane (Dr. Helen Spurway), Dr. S. M. Manton, Prof. P. B. Medawar, Dr. Joseph Needham, Dr. C. F. A. Pantin, Dr. O. W. Richards, Dr. E. S. Russell, Dr. W. R. Thompson and Prof. F. E. Zeuner. The preface notes that all the British contributions, and some of the others, were secured by Mr. Cedric Dover. These names are by themselves a guarantee of a lively and important symposium, and the abstracts indicate that some of the most fundamental concepts of biology are directly attacked or implicitly discarded by the proposal of new approaches. Some papers, led by those of Drs. Pantin and Manton, are concerned with functional morphology; and several Indian contributions are obviously inspired by Dr. Hora's biogeographical theories. The gene theory is not favoured by some authors, while others have written within its conventions; and, though the idea of adaptations in one way or another is almost a keynote of the symposium, it is also seriously criticized and modified, especially by Drs. Russell and Thompson. Indian biologists are not as well represented as they might have been if the organization could have been more leisurely; but the abstracts suggest that papers of wide general interest have been provided by Drs. E. K. Janaki Ammal, C. P. Gnanamuthu, A. K. Ghosh and A. Bose, Sunder Lal Hora, K. and C. Jacob, H. K. Mookerjee, Sivatosh Mookerjee and M. L. Roonwal. A whole number of the *Bulletin of the National Institute of Sciences of India*, which will be published within the new few months, will be devoted to this symposium.

Society for the Bibliography of Natural History

THE annual general meeting of the Society for the Bibliography of Natural History was held at the British Museum (Natural History) on March 30. Mr. Walter Necker spoke on "The Unsystematic Systematist, and Other Random Observations on Bibliography in England and America". It was reported that preparations were actively going forward for the production of the first part of the third volume of the Society's *Journal*. The following officers of the Society were declared elected: *President*, Dr. J. Ramsbottom; *Honorary Secretary and Treasurer*, Mr. A. C. Townsend, British Museum (Natural History), Cromwell Road, London, S.W.7; *Committee*, A. G. Davis, W. N. Edwards, F. C. Fraser, F. J. Griffin, W. T. Stearn and C. Kirke Swann.

Laboratory Animals Bureau Congress

THE sixth Laboratory Animals Bureau Congress was held at the Royal Veterinary College, London, during March 27–28. Some two hundred and fifty technicians from all parts of Great Britain attended. The Congress was opened by the secretary of the Medical Research Council, Sir Harold Himsworth. Six short papers were read by technicians, and one long one, on reproduction in mammals, by Dr. I. W. Rowlands, of the Agricultural Research Council Institute of Animal Physiology, Babraham. Visits were paid to the National Institute for Medical Research, Mill Hill, and to the Lister Institute at Elstree, and a programme of films of zoological interest was shown at the College. Chairmen at the four sessions were Prof. S. P. Bedson, Dr. L. Harrison Matthews, Dr. R. Lovell and Prof. R. E. Glover. As

in previous years, the Animal Technicians Association held its annual general meeting at the time of the Congress. The proceedings of the Congress will be published in full in the *Journal of the Animal Technicians Association*.

Applied Microbiology

Microbiology is now well established as a scientific discipline, and the publication of the results of fundamental research is fairly well catered for in the journals of the scientific societies. In recent years the application of microbiology to the manufacturing and food industries, to agriculture, and to the many fields in which control of micro-organisms is demanded, has resulted in the presentation of many papers of undoubted value which would, however, be out of place in journals devoted to fundamental research. Many industries, and even branches of industries, now publish the results of applied research, including microbiology, in their own journals. The Society of American Bacteriologists, by sponsoring a new journal, *Applied Microbiology* (The Williams and Wilkins Co., Baltimore 2, Maryland, U.S.A., 6 numbers, bimonthly, per volume annually 63*s*.), evidently considers that there is a place for yet another journal designed, to judge from the general statement of aims and from the list of members of the editorial board, to embrace all fields except animal and plant disease. The project is ambitious, and to achieve the apparent object there will have to be careful selection of papers, to avoid wandering into territory already catered for. The first number (January 1953) contains a catholic collection of papers, of which some at least have that wide appeal necessary to justify the appearance of another journal which must be read.

New York Zoological Society: Aid for Biological Research in Europe

The New York Zoological Society has renewed for 1953 its 'Point Four' programme of aid to biological research in Europe. In 1952 the Society made grants for research to individuals and institutions in Austria, Belgium, Denmark, England, France, Germany, Holland, Italy, Spain, Sweden, Switzerland and Turkey. This year funds will again be made available to research departments or individual investigators in universities, natural history museums, zoological parks, aquariums and non-profit biological laboratories. The use of funds is limited to the purchase of specific items of research equipment, books and technical journals, and the costs involved in providing experimental material. It is not intended to provide assistance to personnel of medical institutions, commercial laboratories, government-sponsored programmes or any programme concerned primarily with applied or economic biology; however, individuals or groups in such organizations are eligible for aid in connexion with any fundamental studies of their own which are being carried out simultaneously but separately. Applications for grants should be addressed to Dr. Ross F. Nigrelli, chairman of the New York Zoological Society European Research Fund, Zoological Park, New York 60, N.Y.

Insects of Micronesia

The Bernice P. Bishop Museum, Honolulu, is now supporting the project known as "Insects of Micronesia" which was hitherto carried on by the Pacific Science Board of the United States National Research Council with funds from the Office of Naval Research of the United States Navy; the National Science Foundation, Washington, D.C., has made a grant of 15,200 dollars to the Bishop Museum to help in continuing the work for the next eighteen months. The project is under the direction of J. Linsley Gressitt, and the results will be published by the Museum as a special series. About four hundred thousand specimens have been assembled from Micronesia, and these are being studied by more than a hundred specialists representing some fifty institutions in a dozen countries. J. F. Gates Clarke, N. L. H. Krauss and Dr. Gressitt have been completing the field-work in the Caroline Islands during 1952–53 under a contract by the Office of Naval Research.

Announcements

The Stas Medal of the Société Chimique de Belgique was presented to Prof. F. A. Paneth, professor of chemistry in the University of Durham, on the occasion of the general meeting of the Society on March 22.

Prof. Jean Leray, of the Collège de France, Paris, has been elected a member of the Mechanics Section of the Paris Academy of Sciences in succession to the late Prof. E. Vessiot. Prof. Christian Champy, professor of histology in the University of Paris, has been elected a member of the Anatomy and Zoology Section of the Academy in succession to the late Prof. C. Pérez.

The National Coal Board has appointed Mr. A. Whitaker to be director of extra-mural research. In addition to its own research establishments at Stoke Orchard and Isleworth, the Board has extensive research interests in several research associations and also sponsors projects at a number of universities and with commercial firms. This work will in future be directed by Mr. Whitaker, who will be responsible to the director-general of research at headquarters, Dr. W. Idris Jones. Mr. Whitaker is a physicist; during the War he was with the Parnall Group of companies and was awarded the O.B.E. for work in connexion with aircraft equipment.

The Zoological Society of London is offering a limited number, not exceeding six, of research studentships to senior undergraduates reading zoology, tenable during the summer vacation for a minimum period of four weeks at the Society's Gardens, Regent's Park, or at Whipsnade Park, where laboratory and other facilities are provided. Work which includes observations on living animals will be given preference; experiments requiring licences are not allowed. Grants in aid of travelling expenses and a subsistence allowance for those living away from home may be awarded. Applications, giving particulars of the applicant's age and attainments and a brief outline of the work proposed, and supported by the head of the department in which he or she works, should be sent before April 30 to the Director, Zoological Society of London, Regent's Park, London, N.W.1.

In a paragraph in *Nature* of February 21, p. 332, entitled "A Dominant Sex-linked Mutation in the House Mouse", summarizing a paper by E. D. Garber published in *Science*, **116**, No. 3004 (1952), the gene 'bent-tail' and its morphological effects were described. Dr. D. S. Falconer points out that he had already recognized a sex-linked gene, 'tabby', with morphological effects in the mouse (see *Nature*, **169**, 664; 1952).

DISTRIBUTION OF ANIMALS AND PLANTS IN AFRICA

A WHOLE-DAY meeting of the Linnean Society of London was held in the Society's rooms at Burlington House on January 29. The subject for discussion was "Problems of Distribution of Animals and Plants in Africa". In opening the meeting, the president of the Society, Lieut.-Colonel R. B. Seymour Sewell, stressed the importance of a sound taxonomic background to studies on distribution. Only when one knew with what species one was dealing was it possible to answer questions regarding its place of origin, method of spread and eventual isolation. Other studies of importance to the biogeographer were palæontology and climatology, including the study of past climates.

The first paper was read by Mr. E. Milne-Redhead, of the Royal Botanic Gardens, Kew, who dealt with the distributional ranges of flowering plants in tropical Africa. Of the three arid regions, the Sudanese is by far the poorest and the south-western the richest floristically. The northern savannas exhibit drier (Sudanese) and wetter (Guinean) zones characterized by the presence, in the former, of numerous species of *Acacia* and, in the latter, of *Isoberlinia*. *Brachystegia*, which is abundant in the wetter part of the southern savanna, is absent from the corresponding zone of the northern. An additional feature of the southern savannas is the presence of a thicket vegetation in the dry areas of central Tanganyika. The Kakamega forest marks the extreme eastern limit of the Congo forest, which was at one time much more extensive in Uganda than it is to-day. The vegetation of Uganda is now largely secondary and very difficult to classify. The existence of a complete gap in the dry area of the Gold Coast and Togoland is to be noted, as is the constriction of the Congo forest in the neighbourhood of the 15th meridian, which may mark the site of a former route for migration between the northern and southern savannas. The extension of forest into the savannas in the form of fringing forests along the rivers should also be noted. The small relict areas of lowland forest along the east coast are floristically different from the Guinean and Congo forests. Mr. Milne-Redhead concluded by describing distributions of individual species illustrating points of special interest. He ended with an appeal to zoologists to restrict the term 'Ethiopian' to the territory formerly known as Abyssinia instead of applying it, as now, to tropical Africa as a whole.

Mr. R. E. Moreau, of the Edward Grey Institute, Oxford, followed with a paper on the distribution of African evergreen-forest birds. He began by stating that, contrary to general belief, birds are excellent zoogeographical material. Those of tropical Africa are very strictly confined to their habitats, so much so that where the latter form isolated ecological islands the avifauna frequently shows a high degree of subspecificity, an indication of the thorough reproductive isolation of populations even when these are in close geographical propinquity. Over most of tropical Africa the 5,000-ft. contour forms the lower limit of the montane forest birds; but in certain areas, as in the mountains near the Indian Ocean, the transition takes place at altitudes as low as 3,000 ft. Broadly speaking, it may be said to take place between the annual isotherms of 18° C. and 21° C. Owing to the present very great restriction of most of the African montane forests and their isolation from the lowland forests, due partly to a dry climatic cycle and partly to human exploitation, it can only be studied in unbroken series in some areas of the eastern Belgian Congo and, on a smaller scale, on hills near the Indian Ocean. It is a remarkable fact that even in such areas as these the avifauna of the montane forest is almost as different from that of the lowland forest as it is from that of the savanna. Despite this, however, many montane species have a wide distribution in isolated forests. (An extreme example is afforded by the resemblance of the Cameroon Mountain avifauna to that of East Africa.) As against this the Abyssinian mountain fauna is much poorer than might be expected, while the degree of subspeciation even on closely adjacent mountains in East Africa is high. In conclusion, Mr. Moreau suggested some possible features of the climatic history of the continent which might help to account for these facts. Viewed *in toto*, however, the problem of the origins of the present distribution of forest birds remains a most baffling one.

The last paper of the morning session was read by Dr. A. T. Hopwood, of the British Museum (Natural History), on the origin and history of the African mammalian fauna. He began by stressing the difficulty of dating the available fossil remains. This arises mainly from two causes, the virtual absence of marine deposits and the difficulty of distinguishing ecological differences from differences of age. Like the birds, the mammals tend to be closely restricted to their preferred habitats, and in consequence distinct savanna and forest forms may be found in close geographical proximity. Oligocene deposits are rich in Hyracoidea and Proboscidea, both of which are probably African in origin, although the Oligocene Proboscidea of Baluchistan have some very primitive features. The Oligocene of the Fayum and of Baluchistan is also very rich in anthracotheres. Large collections are available from the Lower Miocene of Central Africa. These have not yet been fully worked out; but the fauna is known to have contained primitive mastodons, very close to those of the Upper Oligocene of Baluchistan, well-developed chrysochlorids (an apparently autochthonous group) and many rodents and creodonts as well as the earliest known fossil aardvark. The latter may possibly have been a Lower Miocene or Oligocene invader. The Miocene fauna of Kenya shows a close resemblance to that of south-west Africa, except that the latter contains no primates. No Pliocene remains are yet known. The Pleistocene fauna shows a very close resemblance to that of the recent era, many forms being scarcely even specifically distinct. Hippopotamus and giraffe first appear in Africa in the Lower Pleistocene and were almost certainly invaders from Asia, perhaps from India.

In the afternoon the chair was taken by Dr. W. E. Swinton. Mr. P. F. Mattingly, of the British Museum (Natural History), opened the session with a paper on the distribution of African mosquitoes. He began by discussing the climatic limits of Chapin's faunal districts, speaking mainly with reference to the subgenus *Stegomyia*. Only two species of this subgenus are naturally distributed throughout the Upper and Lower Guinean Forest districts, an example of the exclusive nature of the evergreen forest. Both species

extend into the surrounding savannas. To the north they are limited by the 40-in. isohyet which here seems to form the natural boundary of the West African subregion. To the east they extend into the Kakamega forest, and the limit here seems to be an altitudinal one, about 5,500 ft. in the case of one species and about 6,000 ft. in the case of the other. To the south this difference allows one species to spread up on to the Rhodesian plateau, while arresting the other at about 3,500 ft. and confining it to the western subregion. Evidence was brought to show that the effect of rainfall on distribution may be largely indirect, the operative factor being the subsoil water-level which determines the nature of the vegetation, and so of the microclimate. The existence of a West African savanna species with a discontinuous distribution in the coastal area of Natal and Zululand indicates a former much wider extension of the central African forests. The affinities and distribution of the East African Highland fauna were discussed, and attention was directed to the existence of a typical member of the African group of *Stegomyia* in a restricted area of eastern Asia. This was discussed in relation to the origins of the African fauna, and notes were given on geographical variation and the zoogeography of introduced species.

Prof. P. C. C. Garnham, of the London School of Hygiene and Tropical Medicine, then read a paper on the distribution of blood protozoa in Africa. He said that, with the exception of a few groups of special importance, this was practically a virgin field. In addition to the two factors discussed by previous speakers, the organism and its environment, it was necessary to take account of two more, the host and the vector. There could be no zoogeography of the blood protozoa *per se* but for the fact that there occur cases in which the host and the vector are present but the parasite is not. The factor of human interference was of special importance because man could act separately on parasite, host or vector, exterminating or reducing them or increasing their numbers by importation, domestication or transportation to more suitable environments. The best parasites to study would be those whose hosts are static or have a limited range. Unfortunately, data concerning these are scanty. Examples were then given from the malaria parasites, of which the human forms occur throughout Africa, except in deserts and above certain altitudes (about 9,000 ft. in equatorial latitudes), the related Hæmoproteidæ, the hæmogregarines, the trypanosomes and the piroplasms, all of which show interesting examples of discontinuous or restricted distributions.

Dr. W. E. Kershaw, of the Liverpool School of Tropical Medicine, followed with a short paper on the distribution of human filarial parasites in West Africa. He said that the distribution of these parasites could be related in varying degrees to the vegetational zones, though less clearly than in free-living animals. The human parasite *Loa loa* occurs, it is believed, also in monkeys. It is transmitted by biting flies (*Chrysops*), which feed on monkeys in the canopy and on man either on the ground or in houses built on ridges level with the canopy. The parasite is confined to the evergreen forest and disappears as soon as the forest fringe is crossed. *Acanthocheilonema perstans* is also ubiquitous in the forest and absent from the mountain grassland, despite the presence there of one of its vectors (*Culicoides* spp.). It is also abundant, however, in the arid, eroded grasslands of the Bauchi plateau. It seems, therefore, that, in this case, very different vegetational zones can provide suitable conditions for the maintenance of the parasite.

This session concluded with a paper by Dr. E. B. Worthington, of the Conseil Scientifique pour l'Afrique au Sud du Sahara, on the distribution of freshwater organisms. He said that the continent could be divided into ten aquatic regions, but confined his remarks mainly to the eastern and central area comprising six regions, the Nilotic, Victorian, Tanganyikan, Nyasan, Zambesian and East Riverain, pointing out that these were not all coincident with drainage basins because in some cases differences in ecological conditions formed more potent barriers than dry land. Small freshwater organisms and even fish may become airborne at times. Discussing the mode of origin of present-day distributions, he suggested a hypothesis, based on past tectonic and climatic changes, to account for the picture now presented by the great lakes of East Africa. This hypothesis, he said, had first been put forward twenty years ago, but it had stood the test of time and still seemed worth restating. Active work was in progress and details were continually being filled in. Finally, he directed attention to the great interest of studies on such phenomena as the *Haplochromis* species swarms of Lake Victoria for general evolutionary theory and for our understanding of the mechanism of speciation. He said that, despite criticism, he still adhered to his opinion regarding the importance, in this connexion, of the absence of predators. He concluded by referring to the factor of human interference. This had a long history but had recently been intensified by such developments as fish farming and the use of fish in the control of disease. In some cases it was irretrievably altering local conditions before sufficient had been learnt about them.

The whole of the evening session was devoted to an open discussion. Contributions of the principal speakers will be published in full, with a report on the discussion, in the *Proceedings of the Linnean Society*.

P. F. Mattingly

THE BIRTH OF FLIGHT*

By the Right Hon. LORD BRABAZON OF TARA, P.C.

ALTHOUGH from earliest times smoke must have been noticed to arise from fire, it was not until the eighteenth century that the brothers Montgolfier realized the principle of using hot air to make a balloon rise. Yet such a primitive people as the Australian aborigines invented the boomerang, which aerodynamically shows three remarkable characteristics: the lift obtained from a surface which is flat on the underneath but curved on the top; the recession of the axis of rotation due to a force on one side of the rotating body; and the auto-rotating effect of a boomerang due to the change of kinetic energy into rotational energy (at the end of its flight the boomerang rotates more violently than when launched).

Nature provides a varied selection of methods of flight. Thus there are the gliding seeds, of which a number among the conifers give remarkably long glides, and auto-gyration in Nature is illustrated by

* Substance of a Friday Evening Discourse delivered at the Royal Institution on February 20.

the fall of an ash seed which, with but one wing, rotates at a high speed and can be carried a long way by the wind. The flapping wing is the most obvious mechanism of flight observed in the animal world; but the position occupied by birds both in normal flight and in landing clearly shows the impossibility of designing a machine along these lines by an engineer.

Mr. R. T. Parham, of the Society of Model Aeronautical Engineers, has built two remarkable flying models (demonstrated during the Discourse): one a helicopter which remains almost stationary in mid-air, and another of the flapping wing type, weighing complete less than ¼ oz., which performs most creditably.

It is curious that nobody seems to have studied the gliding of birds with wings of high aspect ratio (that is, long and narrow), such as the gull or albatross, which can achieve a gliding angle of about 1 in 12 (though modern gliders can now exceed this, the limit being about 1 in 42); had this type of gliding in Nature been studied earlier, there is nothing that our ancestors could not have constructed along these lines, even with the materials available two thousand years ago.

Sir George Cayley (1774–1857) was a pioneer who should be remembered, for not only did he invent the hot-air engine and the tension-spoke wheel, but he also made very remarkable model gliders. Cayley had correspondence with Stringfellow regarding the building of a big machine with steam engines, and a quotation from one of his letters—"We must go slow, I assure you before flight is safe a hundred necks will be broken"—is a classical understatement in prophecy.

The Royal Aeronautical Society was born in 1866; but it was not until 1896 that Lilienthal, a very great man, started his series of glides which may be looked upon as the basic beginning of modern flying. Chanute biplanes with movable surfaces were the inspiration of the experiments in gliding made by the Wright brothers, and in 1902 they made more than a thousand glides, some as long as 600 ft. in winds up to 36 m.p.h.

Putting to one side the flights of Santos Dumont with powered airships early this century, the history of power flight is marked by the experiments in 1894 of Sir Hiram Maxim and by the machine which S. P. Langley built in the United States. After efforts had failed to launch the Langley machine from the air off a scaffolding instead of along the ground, the experiments were abandoned on December 8, 1903, and nine days later, on December 17, the Wright brothers made their first flight; whether Langley's machine would or would not have flown is problematical, but if it had been launched another way it certainly should have risen.

Remarkable developments in the construction of engines were made by the French with their rotary radial engine and the V-type *Antoinette*. The great *Antoinette* machine flown by Latham only just failed to cross the English Channel on two occasions, and this feat was achieved by the Blériot machine in 1909 with its three-cylinder air-cooled engine. Although the Americans and French would appear to have dominated the early stages of power flight, yet the British achievements with machines flown by Cody, Roe, Moore-Brabazon and others should not be overlooked, and remarkable work was done by Edward Busk at the Royal Aircraft Establishment well before the First World War.

PARLIAMENTARY AND SCIENTIFIC COMMITTEE

ANNUAL REPORT FOR 1952

THE annual report of the Parliamentary and Scientific Committee for 1952* lists addresses and discussions at meetings of the general committee during the year. Included among these addresses are that by Lord Woolton on government organizations concerned with research and technology, by Dr. J. B. Conant on Anglo-American scientific relations, by Mr. T. M. Herbert on "The Present Scope of the Railway Research Programme" and by Sir Andrew McCance on "Application of Research in the Steel Industry". Addresses were also given on "Management and the Better Use of Science and Technology in Industry", and, followed by discussions, on "Foot-and-Mouth Disease" and the "Shortage of Science Teachers and its Consequences".

The report records the motion tabled on December 5 by Mr. Austen Albu but not debated; this motion, after recording the necessity for a great expansion in exports—particularly of those goods which require for their design and manufacture a high degree of research, technological development and scientific organization of production—urged the Government to take all possible steps to accelerate the more intensive application of the results of research and scientific discovery. For that purpose, it recommended that particular attention should be paid to the importance of ensuring: (1) adequate and long-term arrangements for financing industrial and agricultural research, whether by individual firms, research associations, government establishments or other means, and all consequential action necessary to ensure the fullest appreciation and application of the results of that research; (2) the use of the capital investment programme to encourage more rapid and effective applications of the results of scientific research in the agricultural, industrial and Colonial fields, with adjustments of taxation to assist small businesses engaged on work of scientific development; (3) the provision of the best possible scientific advice at high levels in connexion with all policy decisions relating to capital investment, industrial re-organization and controls concerned with the use of man-power and materials; and (4) an increase both absolute and relative in the number of scientific workers and technologists in all industries and accordingly the most rapid possible expansion of the facilities for their education in the universities, technical colleges and other educational establishments by the provision of sufficient money and materials and by steps to improve the supply of science teachers for the schools.

As a result of further meetings of the Colonial Sub-Committee, a memorandum dealing with questions relating to education, agriculture and fisheries, health, forestry and the future of the Colonial Development and Welfare Fund was prepared, and approved by the General Committee on December 16. In connexion with the last-named Fund, the memorandum included the following statement.

"All plans for the effective application of science and technology in the Colonial territories depend to a large extent on the availability of funds from this source, and as most of these plans are inevitably of a long-term nature it appears desirable that the

* Annual Report of the Parliamentary and Scientific Committee. Pp. 24. (31 Palace Street, London, S.W.1.)

funds should not only be increased in volume but that arrangements should be made for sufficient monies from them to be available for several decades ahead. This is particularly important so far as assistance to Colonial education is concerned. Our review of the evidence which we have heard leads us to the conclusion that progress towards the better application of science and technology in Colonial territories depends primarily on opportunities for elementary education being widely extended. Until education is so broadly based that the vast majority of the indigenous population has become literate there will be no chance of obtaining technically trained field workers in sufficient numbers; nor will such field workers as do exist be able to obtain from villagers and peasantry that degree of intelligent co-operation without which theory, however sound, can never be translated into practice.

"It appears unquestionable that the successful development of the Colonial Empire depends chiefly on the more efficient application of modern scientific knowledge and methods in such fields as agriculture, forestry, medicine or veterinary science and in other activities connected with the development of natural resources. But such efficient application depends in its turn very largely upon the technical competence of the indigenous populations and their ability to take an active part in the process."

BUDGETS OF THE SCIENTIFIC DEPARTMENTS OF THE UNIVERSITY OF CAMBRIDGE

By Sir LAWRENCE BRAGG, O.B.E., F.R.S.

An analysis has recently been made of the recurrent annual expenditure for seventeen scientific departments in the University of Cambridge. A brief summary of the figures is given below, as they may be of general interest. I am much indebted to the University treasurer, Dr. H. M. Taylor, for providing me with the material and assisting me in preparing this summary. The figures relate to the financial year 1950–51.

Some explanation of the basis of the analysis is necessary. For some years an analysis has been made of the expenditure in the Cavendish Laboratory, and a reasonable allocation of the budget between research and teaching shows that one research worker costs as much as ten full-time undergraduates. In arriving at this figure it is reckoned that the time of the staff is divided equally between teaching and research, and other items, such as assistants' wages, materials and apparatus, are allowed for. The 'cost per effective research worker' is arrived at by adding to the number of staff, holders of research fellowships and scholarships and Ph.D. students, one-tenth the number of full-time undergraduates (due allowance being made when undergraduates only get a part of their teaching in the Laboratory), and dividing the total itemized costs by the total number so obtained. In the Cavendish Laboratory, for example, an estimated cost of £755 per 'effective research worker' implies a cost of £75 a year for an undergraduate student. It must be remembered that the last figure only represents the University's contribution to his teaching, a very substantial part of which is provided by his College.

The expenditure includes the contributions to research made by outside bodies such as the Department of Scientific and Industrial Research and other government bodies, and by industry; in other words, the complete budget of each department. The capital cost of buildings and of large items of equipment such as the cyclotron is not included; but the recurrent expenditure of maintenance and of providing assistants to run apparatus has been taken into account. A proportionate share of the cost of the central administration and of the services of the Buildings Syndicate is added to the budget of each department.

For the scientific departments as a whole the staff and students are made up of: graduate staff, 340; research students, 561; undergraduates, 2,870; research assistants, 80; and assistant staff, 745. The volume of the buildings is 12·797 million cu. ft., the volume per 'effective research worker' being 15,000 cu. ft. The current expenditure during the financial year 1950–51 for the scientific departments is as follows:

	Totals	Per effective research worker
Administration	£82,244	£69
Teaching and research salaries	411,266	346
Assistant staff wages	156,095	131
Supplies	149,386	125
Heat, light, water*	32,185	27
Repairs and maintenance*	49,673	42
Totals	£880,849	£740

* The annual cost of heat, light and water per thousand cubic feet is £2·5, and that of repairs and maintenance £3·9.

When a research student is admitted to one of the Cambridge laboratories, he is therefore in effect being given a research grant of £740 a year. This does not, of course, imply that, if an extra research worker is taken on, the budget is automatically increased by this amount, or vice versa if the number drops, since many of the charges are fixed charges which can only be altered by a general expansion or contraction of the department taking place over a long period. The figures do not include the fellowships, scholarships or maintenance allowances paid to research workers who are not on the staff. If we take these grants to be on the average £500 a year, the cost to the community of maintaining a scientific research worker at Cambridge is, in round figures, £1,250 a year.

The figures for individual departments vary considerably, but most lie in the range £600–900 a year. The costs of physics and chemistry, which are the largest scientific departments, are very close to the average value. For the Cavendish Laboratory the staff and students are made up of: graduate staff, 32; research students, 117; undergraduates, 544; and assistant staff, 88 (including research assistants). The expenditure for the Cavendish Laboratory is as follows:

	Total cost	Cost per research worker
Administration:		
Departmental £5,506		
Central £6,600	£12,106	£70
Salaries	44,752	257
Wages	25,694	148
Supplies	33,419	192
Heat, light, water	7,277	41
Repairs and maintenance:		
Departmental £4,496		
Central £3,723	8,219	47
Totals	£131,467	£755

As might be expected, costs for the literary faculties are considerably lower. When calculated on the same basis of one research worker being equivalent to ten undergraduates, the average figure is £416 a year as compared with £740 a year in the scientific faculties. Assistants' wages, supplies and services are expensive items in the scientific budgets.

DEPOPULATION AND RURAL LIFE IN SCOTLAND

IN 1948, the Social Survey of the Central Office of Information was asked by the Department of Health for Scotland to carry out, in selected areas of Scotland, an investigation into rural living conditions and the causes of rural depopulation. The three areas were the Solway counties of south-west Scotland, the Tweed Basin, and north-east Scotland, within the counties of Aberdeen and Banff.

The Solway area was the subject of a detailed report. In the other two areas the results of the investigations showed that conditions there differed only slightly from those obtaining in the south-west. A cursory examination of the three sets of results revealed that, in the districts that were surveyed, the main problems of rural life remained the same, although sometimes presented with slightly different emphases. It seems possible, therefore, that the same kind of remedial measures would be applicable to all the survey areas. On the other hand, the analyses of the results from the Solway survey left in doubt the fundamental factors that had caused the decline of the population of the area. An attempt has therefore been made to isolate these factors with the aid of material from the Tweed and the Aberdeen inquiries, together with the results of a postal questionnaire sent to persons known to have migrated in the preceding twenty years*.

A summary of the major findings showed that, in the rural areas studied, a tenth of the adult population said they would prefer to move away; but the proportion varied from county to county. Wigtownshire and Peebleshire showed a rather higher proportion of potential migrants (those counties being more isolated and less well served with modern amenities than others), while in the better-served counties of Selkirk and Berwick the proportion was somewhat lower than the average. Only a small minority (17 per cent) of the potential migrants had actually made plans to move within a year of the date of interview, giving an average of 1·7 per cent of the adult population of the survey areas whose desire to move had reached the stage of action. People related to earlier migrants tended to become potential migrants themselves slightly more often than people who were not so related. They were also rather more conscious of the advantage of urban forms of life.

Analysis showed that national and local government, the building industry and the personal service industries produced a rather higher than average proportion of potential migrants. In contrast, there was a significantly smaller proportion of potential migrants from among those employed in agriculture, and from people who were retired or had no occupation. On the other hand, the desire to migrate was most frequently found among professional workers, clerical workers and the managerial and executive grades. The supervisory and skilled operative grades produced a smaller than average proportion of potential migrants. Within agriculture, farmers, bailiffs and foremen showed the smallest proportion of potential migrants of all occupations.

The desire to move was expressed rather more often by the young and the single people than by the old and the married. Thus, while of the general population of the survey areas 20 per cent were under thirty years of age, among the potentially migrant group 37 per cent were of this age.

The situation of the informant's dwelling had only a small degree of association with his desire to move or to remain. Thus, people living in an isolated house, or in a house situated in a small lonely group, were less likely to wish to move away than people living in the burghs. Similarly, people whose houses had no road access were less likely to wish to move than people living on main and other metalled roads. There was a greater degree of association, however, between the informant's subjective estimate of the convenience of the location of his home and the desire to move. Nearly three times as many people who said their homes were situated inconveniently as of those who thought them conveniently located said they wished to move to a town. The majority of houses thought 'inconveniently' placed, however, were in burghs or villages. An analysis of some of the actual conditions of housing and amenity in the survey areas showed that the households of potential migrants were, slightly more often than the average, enjoying a main water supply and main drainage, and were more often provided with gas, electricity, telephone and refuse collection services.

Visits to burghs were rather more frequent among potential migrants than among other people. The reasons for their visits laid a rather greater emphasis upon social calls and entertainments than upon business and marketing, compared with the rest of the rural population.

The reasons which potential migrants gave for their preference appeared to fall into the following major categories: the desire for a better job; the desire to escape rural loneliness and stagnation; the wish for change and new experience; and miscellaneous answers of which a considerable proportion referred to factors such as marriage, transfer by employer, and personal family reasons. Replies to a postal questionnaire showed that migrants had made a considerable advance in occupational skill and position after leaving rural areas. As many as 50 per cent of past migrants said they would not have moved away from the countryside had a better choice of jobs been available there.

From these findings it is difficult to point without hesitation to any single factor which has led to the process of depopulation. The explanations given by past and potential migrants for their wish to migrate offer the most solid indications as to the causes of rural depopulation. Both in the past and to-day the desire for occupational advance appears to have been the most frequent cause of migration, while evidence suggests that migration has, in fact, been accompanied by a rise in occupational status. Secondly, there was a desire to escape from the stagnation and solitude of rural life, a desire for new experience and the more

* Depopulation and Rural Life in the Solway Counties. By Bertram Hutchinson. (N.S. 120.) Pp. iv+110+25 plates. Depopulation and Rural Life in the Tweed Valley. By Bertram Hutchinson. (N.S. 120b.) Pp. ii+60. Depopulation and Rural Life in Aberdeen. By Bertram Hutchinson. (N.S. 120c.) Pp. 63. Depopulation and Rural Life in Scotland. (N.S. 120d.) Pp. ii+36. (London: Social Survey, 1949.)

vivid social life of the towns. Thirdly, there was the migration brought about by rural–urban intermarriage (probably accelerated by the War) resulting in homes being set up in the towns where the husband or wife was already living. Fourthly, some moved or wished to move for a number of circumstantial reasons, such as ill-health, family reasons, transfer by employer, and so on. Finally, there was a miscellaneous group of reasons such as bad climate in the rural areas, or children's education.

These answers make little reference to the general environmental conditions of rural life, such as housing, public services, entertainments, and transport. A careful analysis of the environmental conditions of informants showed that in many respects potential migrants were no worse off than the remainder of the population, and in some ways were actually better equipped on an average. There is, in fact, a suspicion that small improvements in housing and amenities in rural areas have served to whet the appetite of those who have profited by them rather than to satisfy it. It cannot be said that material factors at any time take the centre of the stage in the examination of the causes of depopulation.

The aim, therefore, must be to make possible a satisfactory mode of life for the rural people on a standard which can be compared favourably with urban conditions. In this way any sense of inferiority among rural dwellers can be avoided, while fulfilling their need for self-respect. Such an outcome can be achieved in part by the provision of a more varied field of rural employment; but it must probably be accompanied by fundamental improvements in rural amenities. Better jobs in the country, it seems, must have their counterpart in the possibility of a standard of living that the people have come to expect.

ABSORPTION OF POLYMYXIN BY BACTERIA

By Dr. A. V. FEW and Dr. J. H. SCHULMAN
Department of Colloid Science, Free School Lane, Cambridge

THE five members of the polymyxin group of antibiotics, *A*, *B*, *C*, *D* and *E*, have been shown to possess similar antibacterial spectra and potency[1]. Considerable evidence has accumulated[2–4] indicating that the polymyxins are rapidly bactericidal and not bacteriostatic, although in one paper[5] it was suggested that polymyxins *A* and *B* are bactericidal for small inocula and bacteriostatic for large inocula. In assay experiments, the marked dependence of the minimum lethal concentration of polymyxin upon the size of the inoculum[3,4,6,7] suggests that bacterial absorption of the antibiotic is high.

This communication describes experiments on the absorption of polymyxin *E* by washed suspensions of several Gram-negative and -positive bacteria. The release of soluble cell constituents, initiated by the presence of the antibiotic, and possessing an absorption maximum in their ultra-violet spectra at 260 mμ, has been followed concurrently. Free purines and pyrimidines contribute to this maximum[8,9]. Since microbiological assay of polymyxin is both tedious and not capable of high precision, a simple and accurate method has been developed based upon the

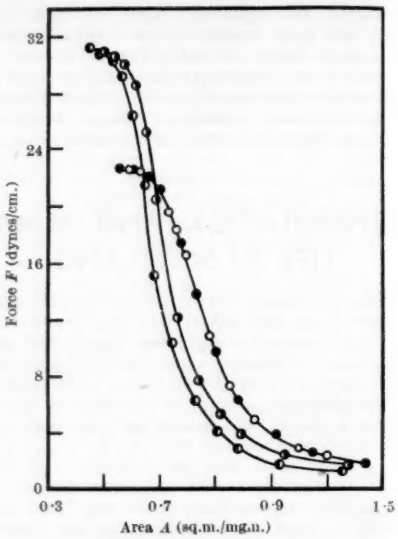

Fig. 1. Force/area curves for polymyxins *A*, ○—○—; *B*, —●—; *D*, —●—; and *E*, —◑—, spread upon 70 per cent (w.w.) ammonium sulphate solution, *p*H 4·5, at 20° C.

observation[10] that the polymyxins form stable unimolecular films at the air/water interface when spread upon 70 per cent (w/w) ammonium sulphate solution. Fig. 1 shows the force/area curves for polymyxin *A*, *B*, *D* and *E* obtained using a standard Langmuir–Adam surface balance. Full details of the properties of these films and estimations of the molecular weights of the antibiotics have been described elsewhere[10]. To determine the concentration of polymyxin in aqueous or buffered solution, an aliquot is spread upon the ammonium sulphate solution, and the area at a surface pressure of 16 dynes/cm. (where compressibility is at a minimum) is compared with that of the standard force/area curve of the particular polymyxin at the same surface pressure. The concentration of the polymyxin solution then follows by proportion. The method is rapid, requires less than 0·5 ml. of solution, and can detect the polymyxins at a concentration of less than 5 μgm./ml. to ± 10 per cent and at 100 μgm./ml. to ± 1 per cent.

For the absorption experiments the bacteria were harvested after 16 hr. growth at 37° C. and washed four times with 0·01 *M* phosphate buffer, *p*H 6·3.

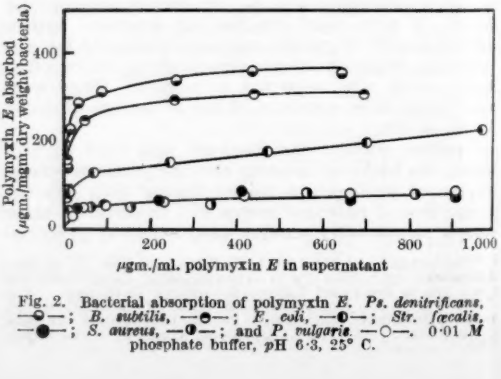

Fig. 2. Bacterial absorption of polymyxin *E*. *Ps. denitrificans*, —◔—; *B. subtilis*, —◔—; *E. coli*, —◑—; *Str. faecalis*, —●—; *S. aureus*, —◑—; and *P. vulgaris*, —○—. 0·01 *M* phosphate buffer, *p*H 6·3, 25° C.

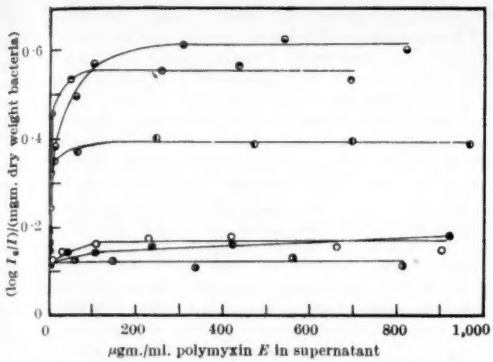

Fig. 3. Release of bacterial cellular material possessing an absorption maximum at 260 mμ. The curves are corrected for the 260-mμ absorption due to free polymyxin *E*. *Ps. denitrificans*, —●—; *B. subtilis*, —○—; *E. coli*, —◐—; *Str. fæcalis*, —◑—; *S. aureus*, —◑—; and *P. vulgaris*, —○—. 0·01 *M* phosphate buffer, *p*H 6·3, 25° C.

using the centrifuge, care being taken to remove any autolysed organisms present. The bacteria were resuspended to 1 mgm./ml. dry wt. in 0·01 *M* phosphate buffer alone and buffered solutions of polymyxin *E* sulphate. 3-ml. samples were incubated for 20 min. at 25° C. The organisms were then removed by centrifugation and the supernatant solution finally cleared by recentrifuging. Aliquots of these solutions were then assayed for (*a*) residual polymyxin by the above method, and for (*b*) the presence of released cell constituents absorbing at 260 mμ, using a Unicam photoelectric spectrophotometer. The control experiments in the absence of polymyxin showed that the amount of cellular material released during the incubation period and forming an insoluble monolayer on the ammonium sulphate was very small, but where necessary was allowed for in the calculation of polymyxin absorbed. Also with certain organisms (*M. lysodeikticus* and *B. subtilis*) almost complete absorption of polymyxin was obtained at low antibiotic concentrations, giving rise to trough areas no greater than those of the control. This indicated that the cellular materials released did not form monolayers upon the salt solution and hence did not interfere in the assay method.

The polymyxin *E* absorption isotherms and released cellular material isotherms for six organisms are shown in Figs. 2 and 3. Determination of the sensitivities of the organisms by streaking 24-hr. broth cultures upon nutrient agar containing increasing quantities of polymyxin *E* showed that *Ps. denitrificans*, *B. subtilis* and *E. coli* were all inhibited by 5 μgm./ml., whereas *S. aureus*, *P. vulgaris* and *Str. fæcalis* were not inhibited by 100 μgm./ml. The results indicate that more polymyxin is absorbed by the sensitive organisms than the highly resistant bacteria. The initial absorption process is complete at polymyxin concentration in the supernatant of 100–150 μgm./ml., after which further absorption is slight. Of four strains of *E. coli* investigated, three showed agglutination phenomena which were maximal at supernatant concentrations of 150 μgm./ml. Similarly, Latterade and Macheboeuf[11] have shown that the *R* form of *E. coli* is agglutinated, whereas the *S* form which contains the *O* antigen is not. Suspensions of *Ps. denitrificans* containing the antibiotic exhibit an increase in optical density also maximal at 150 μgm./ml., and may be due to formation of an insoluble complex between bacterial components and polymyxin similar to those demonstrated between polymyxin and yeast ribonucleic acid[11] and serum albumen[12,5]. Fig. 3 shows that, in the case of the highly resistant organisms, polymyxin causes no significant increase in the release of material showing absorption at 260 mμ when compared with untreated control cells. With sensitive bacteria, however, the presence of polymyxin causes a rapid release of cellular material which is complete at low concentrations of polymyxin in the supernatant. Experiments with *B. subtilis* showed that the absorption of polymyxin and release of material showing absorption at 260 mμ were rapid and unaffected by incubation times between 5 and 60 min.

It is evident that one of the effects occurring immediately after the exposure of sensitive bacteria to polymyxin is a disturbance of the osmotic properties of the organisms and consequent rapid release of cell materials. In this connexion, it has been shown that the injection of polymyxin *E* to a concentration of 0·5 μgm./ml. beneath certain oriented monolayers results in absorption and rapid penetration of the monolayer, although the depression of surface tension of a polymyxin *E* solution at this concentration would be less than 0·1 dyne/cm.

We wish to thank the Wellcome Research Laboratories for the polymyxins, Dr. E. F. Gale for certain bacteria, the Department of Pathology, Cambridge, for culture media and the Medical Research Council for a personal grant to one of us (A. V. F.).

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CHROMATOGRAPHY OF THE GROWTH SUBSTANCES IN PLANT EXTRACTS

By Prof. T. A. BENNET-CLARK, F.R.S., and N. P. KEFFORD
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A METHOD for the chromatographic separation of plant growth substances was described by Bennet-Clark and Tambiah at the Society of Experimental Biology conference in January 1951. Later, they published details of this method[1], which Luckwill[2] has also employed.

For the successful routine chromatography on paper of plant extracts, the original technique has been modified. The plant tissues examined have usually been seedlings, which were chosen for their possible use in subsequent growth studies, and since

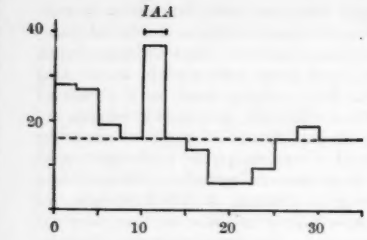

Fig. 1 (*A*)

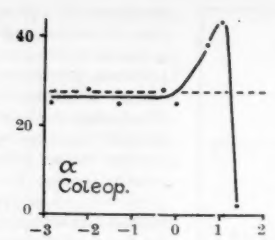

Fig. 2 (*A*)

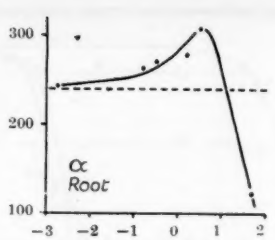

Fig. 2 (*B*)

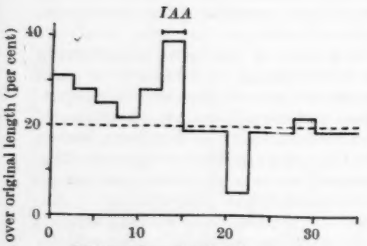

Fig. 1 (*B*)

Activities in coleoptile extension, shown as histograms, of squares cut from chromatograms of etiolated broad bean shoot extract (1 *A*) and broad bean root extract (1 *B*). Broken lines represent the extension of controls, and the position of an indole-3-acetic acid guide-spot is marked *IAA*.

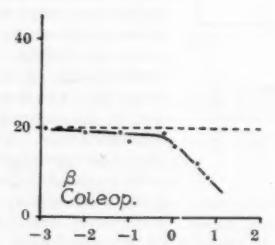

Fig. 2 (*C*)

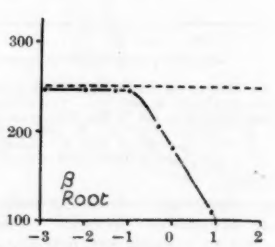

Fig. 2 (*D*)

Activities in coleoptile extension (2 *A*) (2 *C*) and root extension (2 *B*) (2 *D*) of a series of concentrations of accelerator-α (2 *A*) (2 *B*) and inhibitor-β (2 *C*) (2 *D*). Unit concentration is roughly that of the hormone in the tissue (see text). Broken lines represent the extension of controls.

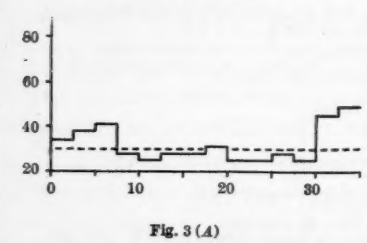

Fig. 3 (*A*)

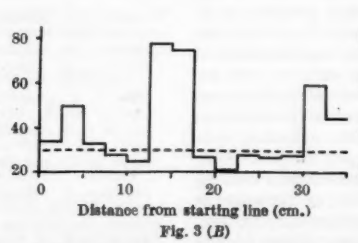

Fig. 3 (*B*)

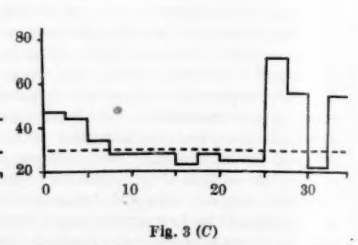

Fig. 3 (*C*)

Activities in coleoptile extension, shown as histograms, of squares cut from chromatograms of *Aegopodium podagraria* rhizome extract after rhizomes had been treated with water (3 *A*), indole-3-acetic acid (3 *B*) and 2 : 4-dichlorophenoxyacetic acid (3 *C*). Broken lines represent the extension of controls. The 15-cm. band is due to indole-3-acetic acid, the 27·5-cm. band to 2 : 4-dichlorophenoxyacetic acid, and one 32·5-cm. band to indole-3-acetonitrile

these were found to be relatively poor in growth substances (compared, for example, with many members of the Cruciferæ), considerable purification was found to be necessary before the extracts could be successfully chromatographed. In order to simplify purification, etiolated tissues were used, and then it was found that the extract fraction containing the acidic substances could be chromatographed without further purification; however, the fraction containing the neutral and alkaline substances usually would have required treatment to remove oils.

The methods used were as follows: macerated plant tissue was extracted with alcohol for twenty-four hours at − 5° C. The alcoholic extract was separated by centrifugation, concentrated under reduced pressure and the aqueous residue extracted with ether at *p*H 3. The ether extract was treated with sodium bicarbonate solution, which was separated and then acidified and re-extracted with ether. The ether-soluble acidic substances from the plant extract, obtained in this final ether extract, were suitably concentrated and applied to the starting line of a chromatogram, as a spot or a strip, from a dropping pipette in a stream of nitrogen. The chromatograms were developed in isopropyl alcohol : water :: 10 : 1, with ammonia in the base of the tank and, parallel with the extract, guide spots of the known growth substances indole-3-acetic acid and indole-3-acetonitrile could be run and their positions detected at the conclusion of the development by spraying with a ferric chloride – perchloric acid mixture and nitrous acid – nitric acid mixture respectively.

The biological testing of developed chromatograms using subapical sections of *Avena* coleoptiles was described previously[1]. A second biological test has been used in which the section 1·5–3·0 mm. from the tip of pea (*Pisum sativum* var. The Pilot) radicles, grown in moist sawdust for four days at 22° C., were shaken at 25° C. for twenty-four hours with 2 ml. 1 per cent sucrose solution containing the growth substances, and their length extension growth measured. Since the presence of paper squares in the test liquid, as used in *Avena* coleoptile bioassay method, could interfere with the pea root bioassay method,

the latter was mainly used for testing solutions of growth substances eluted from chromatograms. To obtain these eluted solutions a large amount of plant extract was applied to paper as a strip and was developed parallel with a spot of the same extract. The chromatogram developed from the spot was cut into 2·5-cm. × 2·5-cm. squares and bioassayed, thus locating the active areas; the parallel active areas were cut from the large chromatogram and eluted by boiling with alcohol and ether.

The results described below have been obtained with a variety of etiolated seedlings and roots, of which the following are examples: pea (*Pisum sativum*) shoots and roots, broad bean (*Vicia faba*) shoots and roots, sunflower (*Helianthus annuus*) shoots, maize (*Zea mays*) roots, potato tubers and shoots, and *Aegopodium* rhizomes.

On all the chromatograms of the acidic fractions of ether extracts of shoot and root material which have been bioassayed, three active areas have been clearly detected. Figs. 1 *A* and 1 *B* show the results, in the form of a histogram, of bioassays with *Avena* coleoptile sections of chromatograms of extracts of broad bean shoots and broad bean roots, respectively. The position of an indole-3-acetic acid guide spot is shown as *IAA*.

The central active area (R_F = approx. 0·3) corresponds with indole-3-acetic acid, which can be detected in this position as a characteristic coloured spot when a chromatogram of an extract of plant material rich in this substance is sprayed with Fe^{+++} – perchloric reagent. In addition, serial dilutions of eluates of this area, when tested for *Avena* coleoptile section extension and pea root section extension, give typical growth-concentration curves. Assuming that the active area with R_F value less than that for indole-3-acetic acid, as shown in Figs. 1 *A* and 1 *B*, corresponds to one substance, the term accelerator-α is suggested for it, and if the same applies to the area with R_F value greater than indole-3-acetic acid, then the term inhibitor-β is suggested for that substance. Accelerator-α and inhibitor-β have been eluted from chromatograms and serial dilutions of the eluates have been assayed for *Avena* coleoptile extension and pea root section extension; and in Fig. 2 the percentage extension of the sections over original length has been plotted against the logarithm of concentration. The concentration scale was arbitrary, normal or unity being the concentration obtained if all of the eluate were dissolved in the same number of ml. of solvent as grams of plant material were extracted to give the eluate. The shape and the position relative to the axes of the curves shown in Fig. 2 are typical of eluates obtained from several different sources. It may be noted that accelerator-α has a very considerable root-growth promoting effect in 'physiological concentrations'.

Two points of interest arose from an application of the chromatography of plant extracts to a growth study involving the rhizomes of *Aegopodium podagraria*, regarding which we possess special information[3]. Fig. 3 *A* expresses as a histogram the results of a bioassay of a chromatogram of the acidic fraction of an ether extract of these rhizomes. Accelerator-α was clearly detected together with an accelerator, not previously encountered except possibly in traces, which runs very close to the solvent front. This new accelerator has been shown by R_F comparison, also by the characteristic colour reaction on spraying with nitrous – nitric acid and by similarity in growth effects of a series of dilutions, to be very probably indole-3-acetonitrile[4], which although not an acid is carried to some extent from an ether solution into sodium bicarbonate solution and back to ether on re-acidification. Although the chromatogram recorded in Fig. 3 *A* did not show it, chromatograms of larger quantities of rhizome extract indicate the presence of indole-3-acetic acid and inhibitor-β; however, from the evidence shown it is clear that the activity of the indole-3-acetonitrile in these rhizomes is greatly in excess of the activity of the indole-3-acetic acid.

The *Aegopodium* rhizomes can be fed artificially with indole-3-acetic acid or with 2 : 4-dichlorophenoxyacetic acid; each of these treatments causes a characteristic and very considerable modification of their growth-rates and geotropic response[5]. These feeding treatments caused a marked change in the chromatogram of the extract as shown in Fig. 3 *B*, which is of an extract of rhizomes grown in indole-3-acetic acid, and Fig. 3 *C*, which is of rhizomes grown in 2 : 4-dichlorophenoxyacetic acid. Indole-3-acetic acid clearly entered the rhizomes, considerably increasing their normal content, and 2 : 4-dichlorophenoxyacetic acid, which runs on the chromatogram at an R_F value between those for inhibitor-β and indole-3-acetonitrile, also entered in quantity. Neither treatment produced any obvious change in the concentration of accelerator-α, inhibitor-β or indole-3-acetonitrile.

Of particular interest is the occurrence in *Aegopodium podagraria* rhizomes of indole-3-acetonitrile, which previously has been reported only in members of the Cruciferæ. Activity due almost certainly to the nitrile has also been found in chromatograms from potato tuber extracts and has been identified by spraying with nitrous – nitric acid and biological assay.

Since activity in the region 27·5–30 cm. due to indole-3-acetonitrile has been detected clearly in *Aegopodium* and potato, it now appears possible that the small humps shown in this region in Figs. 1 *A* and 1 *B* (bean) are also due to nitrile. Such activity has not always been noticed; but this may be due to its being obscured by impurities running near the solvent front and the fact that the biological testing of the region near the solvent front was often omitted in our earlier assays.

Obviously, investigations under conditions of chromatography favourable to the running of indole-3-acetonitrile should be carried out on the fraction of plant extracts containing the neutral substances where the bulk of the nitrile should be located. Of interest also is the detection and possibility of estimation of the synthetic growth substance 2 : 4-dichlorophenoxyacetic acid in a plant extract.

Without going into detail which will be published *in extenso* elsewhere, it may be stated that all shoot and root materials studied have contained hormones α and β and indole-3-acetic acid. We have no information at present on the nature of either α or β; however, one cannot dismiss the possibility that α is auxin-*a*, the real existence of which is often doubted. No active substance of R_F similar to accelerator-α has yet been detected on chromatograms of extracts of urines of various origins. [Dec. 16.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Use of Tracers in Chemical Dosimetry

The action of X-rays and gamma-rays on a solution of ferrous sulphate in 0·8 *N* sulphuric acid has been studied by a number of investigators[1]. The iron is oxidized to the trivalent state, and the amount of trivalent iron is proportional to the radiation dosage. For this reason the ferrous sulphate solution has been used for radiation dosimetry. The amount of ferric ion is usually measured colorimetrically, photometrically or volumetrically. In the present investigation, some experiments have been carried out to measure the ferric ions radiometrically in order to increase the sensitivity of the dosimeter.

Ferrous ammonium sulphate was dissolved in redistilled water and acidified with sulphuric acid, and iron-59 was added to the solution as a tracer. This solution was irradiated with gamma-rays from a cobalt-60 source. After irradiation, the ferric ions formed were separated from ferrous ions by extraction of the ferric thiocyanate with *iso*amyl alcohol. The activity of the organic phase and of the water phase was then determined with a liquid Geiger–Müller counter tube. From these measurements one obtains the percentage of ferric ions in the irradiated solution.

The radioactive isotope iron-59 used as a tracer in this experiment was made with the Werner synchro-cyclotron by bombardment of copper with 185-MeV. protons. The iron formed was separated by extraction with *iso*propyl ether.

The measurements can easily be carried out with an accuracy of more than 2 per cent. By changing the concentration of the ferrous ammonium sulphate in the solution, one obtains different dosage ranges. It seems possible, for example, to measure the radiation dosage in the range 0–100 r. with an accuracy of ± 2 r. The sensitivity can probably be increased still more. The amount of tracer used must not be so large that it gives a radiation dosage which cannot be neglected in comparison with the dosage to be measured.

Experiments have also been carried out to investigate the suitability of an acid or neutral solution of potassium iodide for chemical dosimetry. The action of ionizing radiation on solutions of potassium iodide has been studied by Lefort[2]. In the present experiments the radioactive isotope iodine-131 was added as a tracer to a neutral, hydrochloric or sulphuric acid solution of potassium iodide, which was then irradiated with cobalt-60 gamma-rays. After the irradiation, the solution was extracted with carbon disulphide and the activity of the organic phase and of the water phase was determined as before.

At the beginning of the irradiation, the iodide is oxidized to iodine in an amount proportional to the radiation dosage. However, a state of equilibrium is soon reached because the radiation also reduces the iodine. This state of equilibrium is reached at 25 per cent iodine for a neutral solution, at 60–70 per cent iodine for a *N* hydrochloric acid solution and at about 35 per cent iodine for a sulphuric acid solution of *p*H 2. The number of iodide ions oxidized by a certain dosage of radiation is considerably lower than the corresponding number of ferrous ions in a ferrous sulphate solution. For this reason one has to use very dilute iodide solutions to get a dosimeter of high sensitivity. However, these dilute solutions do not seem to be stable enough to be useful as dosimeters.

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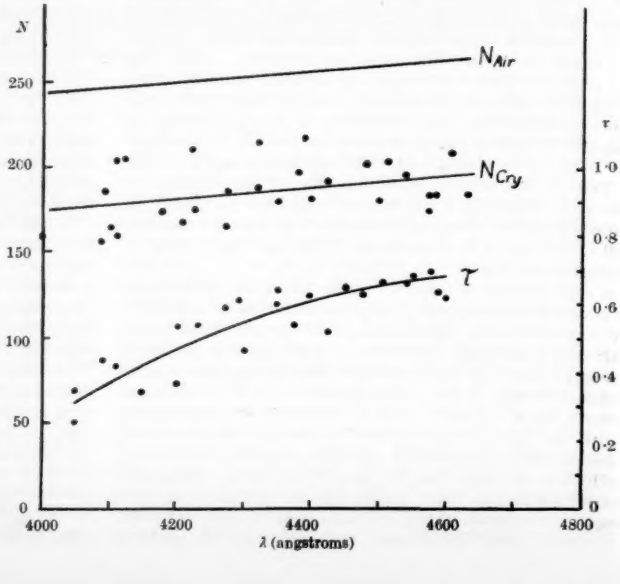
Multi-layer Dielectric Reflecting Films at Wave-lengths between 4000 and 4600 A.

Recent correspondence[1,2] has directed attention to the lack of information about the efficiency of multi-layer dielectric reflecting coatings at wave-lengths shorter than 5200 A.; this prevents an assessment of the relative merits of dielectric and silver films as coatings for Fabry–Perot interferometer plates at these wave-lengths. To this end, multi-layer dielectric interference filters have been prepared, and their characteristics measured over the wave-length range 4000–4600 A.

Each filter was deposited on glass, and consisted of two reflecting films, both of seven λ/4 layers (four zinc sulphide and three cryolite), separated by a λ/2 spacing layer of cryolite, thus giving a first-order



pass-band at wave-length λ. By suitably orienting the glass support in the evaporation chamber, each layer was deposited in the form of a wedge such that λ varied over the filter between 4000 A. and 4600 A. In this way the pass-band at each point of the filter was made to centre on the wave-length for which the reflectivity of the seven-layer films was a maximum.

The half-intensity width and peak transmission of four such filters have been measured for several wave-lengths in the above range by scanning the pass-band, dispersed by a large glass spectrograph, using a multiplier photo-cell in conjunction with an amplifier and recorder. The results obtained are shown in the accompanying graph. N (middle curve) is the ratio of the wave-length of the pass-band to its half-width, and is the "effective number of interfering beams"[2], and τ is the fraction of the incident light transmitted at the peak of the pass-band. From these measurements the geometric mean values of the reflexion, transmission and absorption coefficients for the pair of films in each filter can be calculated, and values for three wave-lengths are shown in the accompanying table.

λ	4100 A.	4300 A.	4500 A.
Reflexion coefficient	0·982	0·983	0·983
Transmission coefficient	0·011	0·012	0·014
Absorption coefficient	0·007	0·005	0·003

These values refer to the system cryolite/7-layer film/glass and would be altered if the spacing layer were air. Theory indicates that the reflexion coefficients would be increased by about 0·005 for the system air/7-layer film/glass, while the ratio of transmission to absorption remains constant. Values of N embodying this correction are shown in the upper curve of the graph.

A comparison of silver and dielectric films as Fabry–Perot interferometer coatings may now be made by comparing values of N for a given τ, since N is directly proportional to the attainable resolution assuming perfectly flat plates. For $\tau = 0{\cdot}45$ at λ 4200 A., new and aged silver films give $N = 16$ and 11, respectively[4], whereas for seven-layer dielectric films N is about 250. The theoretical resolution at this wave-length using dielectric films is thus fifteen to twenty times that obtained with silver films. In practice, of course, the resolution is limited by imperfections in the interferometer plates; but whereas silver films do not allow full advantage to be taken of good-quality flats, dielectric coatings are evidently more than adequate.

The performance of interference filters is not subject to this limitation, since irregularities of the glass support are of no account, and full use may be made of the superiority of dielectric coatings. For example, at λ 4600 A. a pair of seven-layer coatings separated by a first-order spacer gives a half-width of 22 A. and a peak transmission of 70 per cent, whereas a first-order silver interference filter might have a half-width of 150 A. and a transmission of 40 per cent[5]. Theoretically, a higher-order spacer would give an even narrower pass-band, but roughness in the spacing layer appears to limit what can be achieved by this means[6]. Improvement, however, is possible by increasing the number of dielectric layers, and a preliminary experiment with a pair of nine-layer coatings separated by a first-order spacer has resulted in a half-width of 15 A. and a peak transmission of 60 per cent at λ 4700 A.

We are grateful to Mr. J. E. Geake for the loan of the amplifier and recorder.

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The Sunspot Number Series

Sunspot numbers form a quasi-periodic series (see Fig. 1, upper curve) going back for eighteen cycles to 1750. Very numerous attempts have been made to analyse the series, with little success. It does not appear to contain a truly periodic term, as do tides and weather records. The fundamental Fourier component, as determined over a particular section of the series, yields only a poor estimate of the next cycle, both in duration and in phase. Very little regularity of any kind has been found.

The objects of analysis have been twofold: to discover a process which would yield a time series resembling the sunspot series, and to predict the future of the series, which incidentally would be very valuable in relation to telecommunications. No suggested process has been substantiated and predictions are made on an empirical basis. The range and accuracy of forecasting would presumably be improved if some hypothesis could be found which would give rise to series resembling the sunspot series.

The present communication presents an idea which could lead to such a hypothesis. According to Hale's well-known discovery, based on observations of the magnetic polarities of sunspots, the sunspot cycle lasts twenty-two, not eleven, years. The upper curve of Fig. 1 does not include this information; but as there is no known difference in the terrestrial effects between successive eleven-year cycles, its

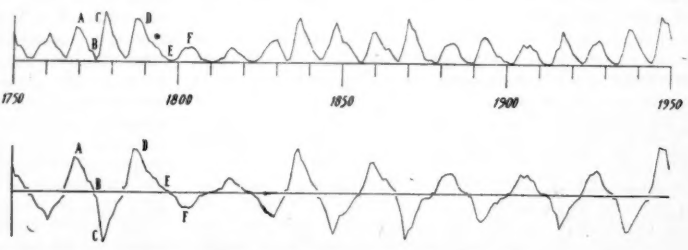

Fig. 1. (Above). Sunspot number series, 1750–1950
(Below). The same series, but showing alternate 11-year cycles reversed in sign

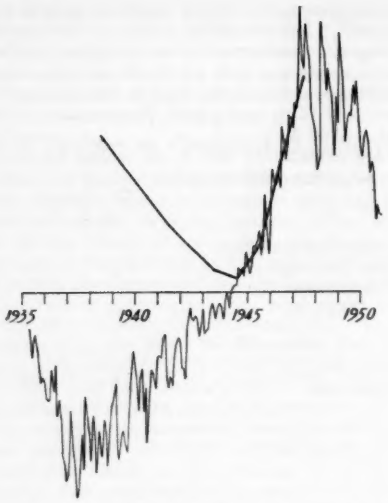

Fig. 2. Monthly means (—) and annual means (—) about the sunspot minimum of 1944

appropriateness has not hitherto been questioned. It is now proposed to plot alternate cycles, positive and negative, as in the lower curve of Fig. 1.

It may be objected that, in years of minimum spots, the sunspot number has not always been zero, whereas the alternating representation requires accurate zeros. In the years 1766, 1784, 1843 and 1944, the minima were very noticeably different from zero. This objection can be met with the aid of Fig. 2, in which the minimum of 1944 is shown in greater detail, by monthly means in addition to annual means. It is clear that the sunspot number actually passed through a very good zero in 1944, but that the taking of annual means obscured this fact. Any further difficulty vanishes when it is remembered that spots belonging to successive cycles are to be taken with opposite signs, and that it is possible to identify which cycle a spot belongs to by taking into account its latitude and magnetic polarity. In plotting Fig. 1 (lower), no attempt has been made to correct the minimum sunspot numbers.

The two curves of Fig. 1 look at least equally regular. In particular, the lower curve does not exhibit obvious discontinuities at the zeros, apart from the gaps due to the above-mentioned deviations of the minima from zero. It has attractive features, such as symmetry about its mean value, and a mean value which is practically zero (less than 1 per cent of mean maximum).

A hypothesis of Yule's[1] likens the sunspot series to the motion of a swinging pendulum which boys are pelting with peas, sometimes from one side and sometimes from the other. After lengthy analysis, Yule concluded that further work on this line seemed to be blocked. Yule, however, began by subtracting the mean value from the series. The series was thus asymmetrically distributed about its zero, and the maximum excursions in the negative direction were all practically equal. It is therefore perhaps not surprising that the stipulated mechanism failed. The present idea re-opens this promising line of investigation.

If the new presentation is significant, a correlation might be expected between the fall of one cycle to zero and the rise of the following cycle, that is, a steep rise might be expected to follow a steep fall to zero. It is found that the correlation coefficient between the average rate of fall from maximum to minimum and the average rate of rise from the minimum to the next maximum is 0·57. In comparison, if the rate of rise is correlated with the rate of fall of the following cycle and the preceding cycle but one, the values are — 0·03 and — 0·001 respectively. As particular examples of this correlation, the steep fall *AB* was followed by the steep beginning *BC*, and the gradual fall *DE* was followed by the gradual beginning *EF*.

The idea of representing the sunspot series as a twenty-two-year oscillation with zero mean value is offered to mathematicians, physicists and engineers sharing a common interest in sunspots. Some past attempts to analyse the sunspot number series may well have been near the truth, but may have foundered on the eleven-year version of the upper curve of Fig. 1.

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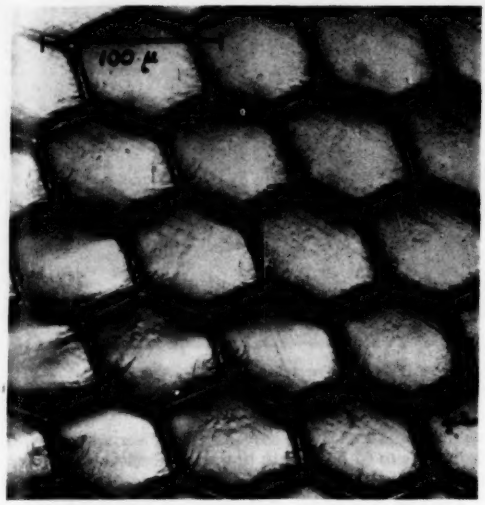
A Special Kind of Growth Structure in Metal Single Crystals

The purpose of this communication is to describe and illustrate the growth of single zinc crystals, using a method in which the growth boundaries are examined, without etching, in their natural relief by means of a stereomicroscope.

The crystals are produced by a somewhat modified Czochralski–Gomperz method, in which the diameter of the single crystal wires is held at about 0·5 cm. If now the crystal wire is suddenly removed from the surface of the melt out of which it is growing, one gets as the termination of the wire a section which is more or less convex according to the temperature gradients prevailing in the region of growth, and which consists of small polygonal units, themselves individually convex.

In the case of zinc, under favourable conditions, remarkably regular hexagons are obtained, as may be seen in the accompanying photograph, which represents the appearance of part of such a termination grown under a steep temperature gradient. The zinc used had a purity of 99·99 per cent, the rate of withdrawal or growth was 30 cm./hr., and the hexagonal crystallographic axis was, in this case, inclined approximately 25° to the axis of the wire. Inside the hexagons there are small raised spots, sometimes only single, which are probably due to traces of dendrites growing out from the interface into the melt. Also there are, running across the whole section, parallel straight lines, traces of 0001 planes, not produced by later plastic deformation. Corresponding to the growth structure at the termination, there is also visible on the outer surface a structure which looks as if the wire had grown in parallel hexagonal strands, with their axes making a small angle (a few degrees) to the axis of the wire.



The growth structure obtained by the above method obviously bears a close relation to the structures which Buerger[1] has obtained by etching with strong hydrochloric acid the cleavage and outer surfaces of zinc single crystals grown by the Bridgman method. The method described here has been successfully extended to other metals; a fuller account of the results will be published elsewhere.

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Gloss of Papers

We have completed a psycho-physical study of the gloss of several series of coated and uncoated papers differing widely in surface finish and in colour, including a black, a green and a mauve, besides an assortment of shades of white, cream, yellow and brown.

Over such a wide range considerable disagreement is found between judgments of individual observers, and marked shifts in ranking occur when the conditions of illuminating and viewing the specimens are changed. Judgment appears to be based upon an appraisal of a physical situation taken as a whole. The factors of this physical situation are weighted differently by different observers under the same conditions and by the same observer under different conditions. Consequently it is possible only to devise a method of instrumental grading which shall satisfy the mean judgment of a large number of observers under certain average conditions of grading. Within these limitations, an extension of an empirical equation previously suggested[1] enables instrumental measurements to be fitted to visual gradings tolerably well. The general expression is:

$$G = AS(a+b \tanh 10/bL) - B \tanh [cS(P-1)/100]^3,$$

and is applied to papers illuminated by a nearly parallel beam incident at 45°, where S is the intensity of light reflected at the specular angle (45°), L the intensity in the direction of the normal (0°) and P is defined as the ratio of intensity at 45° to that at 40°. A, a, B, b and c are constants and G is the numerical estimate of the visual gloss. All intensities are expressed as a percentage of the intensity reflected normally to a surface of magnesium oxide under the same incident beam.

It is seen that the equation represents a weighted mean of three factors. The first is S, the intensity at the specular angle. For papers of high luminance factor and moderate gloss, this factor predominates. The second is ($S \tanh 10/bL$) and provides a measure of the contrast observed when the eye is transferred from the specular angle to a direction remote from the specular angle: the hyperbolic tangent has no physical significance but is introduced in order to prevent G from rising to abnormally high values for black and dark grey papers. The third term, $\tanh [cS(P-1)/100]^3$, is appreciable only for papers at the higher end of the gloss scale. For highly glossy papers having the same values of S and L, the one having the more sharply peaked polar curve is adjudged the less glossy by most observers, and the third term of the equation makes allowance for this.

It appears that in order to get the best possible correlation between G and visual observations, the weighting constants A, a, B, b and c must be adjusted to suit the individual observer and the prevailing conditions of observation. This is generally impracticable and undesirable, and for most purposes we find that the equation reduced to the form:

$$G = S(0{\cdot}390+0{\cdot}325 \tanh 20/L) - 100 \tanh [0{\cdot}115\ S(P-1)/100]^3$$

gives with visual observations product-moment and rank correlation coefficients of the order of +0·94 for all types of paper, and it is suggested that it may be made the basis of a practical method of gloss specification. For comparative work with similar papers where P is small and L nearly constant, the equation can, of course, be simplified. The incident and reflected beams used in this work were in the form of truncated wedges of vertical angle 0° 30′.

Our thanks are due to Prof. B. Steenberg of Svenska Träforskningsinstitutet, Stockholm, for supplying some of the papers, together with the visual gradings of 476 Swedish observers. A detailed account of this work is being prepared for publication elsewhere.

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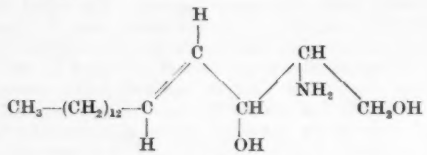
Trans-Ethylenic Structure of Sphingosin

The molecular structure of sphingosin (I) has been established with reasonable certainty by degradation[1] and by the synthesis of the dihydro derivative[2]. Concerning the spatial structure, however, no more can be inferred at present from the available data of optical rotations than that the compound would seem to belong to the D-(−)amino carboxylic acid series[3].

An attempt was made by Ono[4] to decide on the steric disposition of the substituents of the ethylenic

double bond by conversion of the compound with lead tetra-acetate into hexadecenal, and hence to the corresponding hexadecenoic acid to which the author assigns the *trans* structure. Unfortunately, no experimental details of the selective oxidation of (I) are given, or the melting point of the 2-hexadecenal obtained and of the other geometrical isomer of hexadecenoic acid, or the principle used for establishing the configurations.

The investigation of the configurational correlation[5] of (I) to the four theoretically possible threoninol isomers is expected to disclose the configuration of both asymmetric centres in (I). The work being in progress at our laboratory, at present we offer the evidence on the spatial structure of the olefinic chain in (I).



(I)

Carter[6] has stated without further comment that triacetyl dihydrosphingosin melts at almost the same temperature as does triacetyl sphingosin, and the mixture of the two substances shows very little melting point depression. Now, according to the syncrystallization rule of Bruni[7], only the more stable of a pair of geometrically isomeric ethylenes would form mixed crystals with the corresponding dihydro derivative. Since the skeleton of the long aliphatic chain of dihydrosphingosin can have only the staggered orientation, sphingosin cannot be expected to enter the crystal lattice of the former unless it represents the *trans* form of the ethylene bond. Actually, we find that neither the triacetyl nor the tribenzoyl derivative gives a depression of melting point with the corresponding triacyl dihydrosphingosin, the observed values taken with mixtures of various proportions indicating strongly the formation of solid solutions ('mixed crystals') as evidenced by the accompanying photographs and graph. This suggests with a very high degree of probability that

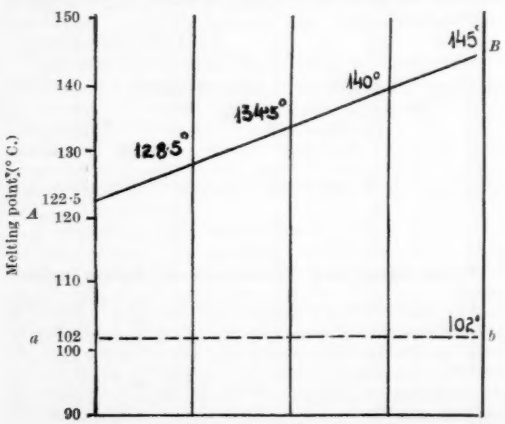


Fig. 1. *A*, Tribenzoyl-sphingosin; *B*, tribenzoyl-dihydro-sphingosin; *a*, triacetyl-sphingosin; *b*, triacetyl-dihydro-sphingosin

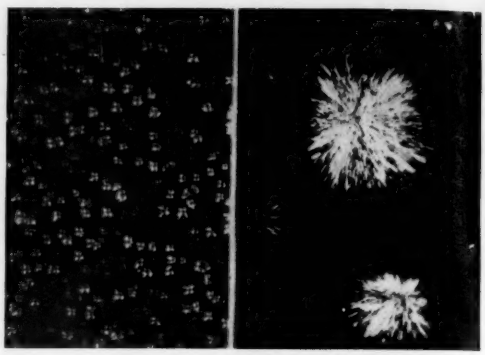


Fig. 2. (Left): Triacetyl-sphingosin + triacetyl-dihydro-sphingosin (equal parts). (Right): Tribenzoyl-sphingosin + tribenzoyl-dihydro-sphingosin (equal parts). (Nicol prism; × 75)

sphingosin has the *trans* ethylenic structure, which would seem to be well in line with the known stability of the compound toward heating and toward alkalis[8].

Further synthetic and physical investigations on the subject will be published in detail in the *Acta Chimica Hungarica*. We are indebted to Prof. S. Koch for crystallographic evaluations, and to Dr. J. Mezősi for the photomicrographs.

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[8] Myers, G. H., *J. Amer. Chem. Soc.*, **73**, 2100 (1951), showed that *cis*-octadecenoic acid undergoes readily stereomutation on the action of alkali, while the *trans* isomer does not.

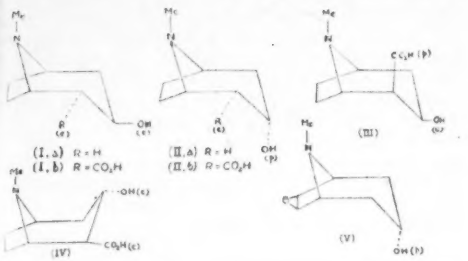
Conformation of Tropane Alkaloids

It has become generally accepted that *cyclo*hexane compounds[1] and pyranosides[2] possess the chair conformation. By analogy we may assume that piperidine and its derivatives also exist in the chair conformation. Starting from this assumption, it is possible to determine the conformation of tropane alkaloids.

The sodium and alcohol reduction of tropinone leads mainly to ψ-tropine. This method of reduction of a ketone is known to afford an equatorial hydroxy substituent[3]. The hydroxy group in ψ-tropine should, therefore, be in the equatorial position and (I)*a* and (II)*a* should represent the conformation of ψ-tropine and tropine, respectively. The fact that tropine can be epimerized to ψ-tropine by the action of sodium amylate supports this view. Similar reasoning indicates an equatorial position for the hydroxy group in ψ-ecgonine. This conformation is in keeping with the observation that ecgonine, which should have the hydroxy group in the polar position, is more readily dehydrated than ψ-ecgonine.

The reduction of methyl tropinone-2-carboxylate leads to the methyl ester of *dl*-ψ-ecgonine, *dl*-ecgonine

and a 'third racemate'—the first-named reduction product being obtained in a preponderant amount. Thus, ψ-ecgonine is the most stable of the four epimers possible for 2-carboxy-3-hydroxy-tropane. Both the hydroxy and the carboxy groups in the unknown epimer should therefore be assigned polar positions, whereas in ψ-ecgonine both these substituents should be equatorial. The conformation of ψ-ecgonine, ecgonine and the 'third racemate' can now be represented by (I*b*), (II*b*) and (III), respectively.



Fodor[4] has deduced the configuration of tropane alkaloids by an elegant investigation and shown that in ψ-ecgonine the hydroxy group is *syn* with respect to the nitrogen and *trans* with respect to the carboxyl group. The conformation (I*b*) is in accord with this configuration. If, however, instead of the chair conformation we assign the boat conformation to the piperidine ring, ψ-ecgonine will be represented by (IV) and the hydroxy will be *anti*-placed with respect to the nitrogen and will therefore be at variance with Fodor's findings.

In view of the ready conversion of scopine to scopolamine—a tetrahydrofuran derivative—the only reasonable conformation for scopine is (V), in which the piperidine ring is in the chair form[4]. This may be counted as indirect evidence in favour of the chair conformation of the piperidine ring in (I) and (II). The conformation of atropine, cocaine and other related alkaloids follows from (I) and (II). It is interesting to note that all the tropane alkaloids possessing mydriatic or anæsthetic properties have the ester group (in position 3) in the polar position.

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Organic Anion Binding by Denatured Bovine Serum Albumin

In the course of investigations in progress in this laboratory on the binding of acidic phosphatides by bovine serum albumin, certain deviations from the commonly accepted properties of denatured bovine albumin prompted a closer study of the binding of an organic anion (methyl orange) by bovine albumin denatured with urea and guanidine hydrochloride. The view that bovine albumin loses its high affinity for methyl orange after denaturation seems to have arisen mainly from experiments employing heat as the denaturing agent[1]. Yet the persistence of high affinity for the dye has been used as evidence for the maintenance of the native state of bovine albumin[2].

It is to be expected that heat denaturation, especially if allowed to result in coagulation of the protein, would tend to decrease the binding power because of the formation of new intermolecular salt bridges and hydrogen bonds between adjacent uncoiled peptide chains. If, however, denaturation is restricted to changes in the spatial relationships of individual molecules with minimal secondary intermolecular associations, as in partial or complete uncoiling of a globular protein, the binding power should increase, since previously 'buried' binding sites would become available in the process. This appears to be true for the heat denaturation of egg-albumin[3]. If one considers the empirically derived binding index of Klotz[4], denaturation *per se*, without secondary aggregation, association and salt-bridge formation between molecules, should produce either no change or an increased binding affinity, as $\Sigma(\equiv NH^+)/|\Sigma(-OH)-\Sigma(-COO^-)|$ already probably represents a minimum value in the native state.

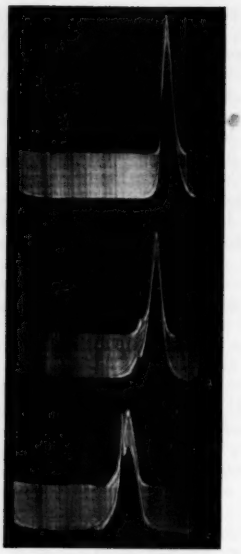
The binding properties of denatured bovine serum albumin have been investigated by comparing the effects of urea and guanidine hydrochloride denaturation on the binding of methyl orange after removal of the denaturing agents. Parallel experiments on bovine albumin denatured with urea and with guanidine hydrochloride were carried out.

The protein preparations used in these experiments consisted of purified bovine plasma albumin (given by Dr. Walter L. Hughes, jun., Laboratory of Physical Chemistry Related to Medicine and Public Health, Harvard University) and Armour crystalline bovine serum albumin. The latter proved to be electrophoretically pure and also homogeneous by sedimentation analysis in the Spinco analytical ultracentrifuge. The methyl orange was a reagent-grade product of the Allied Chemical and Dye Corporation (National Aniline Division).

The bovine serum albumin was mixed with appropriate amounts of powdered urea and guanidine hydrochloride in the dry state and denatured by the addition of water to produce a 40 per cent solution with respect to urea and an 8-*M* solution with respect to guanidine hydrochloride. The denaturing agents were rapidly removed by exhaustive dialysis in the cold, first against water and then against 0·1 *M* phosphate buffer at *p*H 6·5, using a modification of the system described by Wentzel and Sterne[5]. Maintenance of the original total nitrogen to tyrosine ratio of the aliquots at the end of dialysis was taken to indicate complete removal of the urea and guanidine hydrochloride, respectively.

Bovine serum albumin samples treated in the foregoing manner showed increases in relative viscosity, increased digestibility on incubation with trypsin and pepsin, and an increase in the intensity of the colour produced with Folin's reagent[6], as compared with the native albumin. Urea-denatured samples showed an increase in the available guanidinium groups detectable by the modified Sakaguchi reaction[7].

Electrophoretic patterns obtained in runs conducted at *p*H 6·5 (0·1 *M* phosphate buffer) and *p*H 8·6 (0·1 *M* diethylbarbiturate buffer) showed definite changes in the electrophoretic behaviour of denatured bovine albumin solutions, varying in extent



Patterns obtained from the descending limb showing the changes in the electrophoretic behaviour of urea-denatured bovine serum albumin. Perkin-Elmer Tiselius apparatus, 2·0 ml. cell, 165 V.-10 m.amp. current. Time of run in all cases, 86 min.
(*a*) 1·0 per cent native bovine serum albumin in 0·1 *M* diethyl barbiturate buffer, *p*H 8·6.
(*b*) 0·86 per cent urea-denatured bovine serum albumin in 0·1 *M* diethyl barbiturate buffer, *p*H 8·6.
(*c*) 0·86 per cent urea-denatured bovine serum albumin in 0·1 *M* phosphate buffer, *p*H 6·5

with different denatured aliquots, but characterized by decreased mobility and broadening of boundaries with double- and triple-notched peaks (see figure).

Aliquots which showed unequivocal denaturation effects, as determined by the foregoing criteria, were used in binding studies. Dialysis equilibrium experiments were carried out according to the method of Klotz and his associates[5] at 2° C., using a 24-hr. equilibration period. The outside dye concentration was varied in different experiments to bring $2{\cdot}45 \times 10^{-5}$ to $9{\cdot}8 \times 10^{-5}$ mole of dye per millilitre in contact with the protein molecules. The results uniformly showed a greater number of dye molecules bound by the denatured albumin as compared with the native. This is illustrated by the results in the accompanying table.

Data from Typical Dialysis Equilibrium Experiment
10 ml. 0·2 per cent protein solution inside bags except for control. Buffer: 0·1 *M* phosphate, *p*H 6·5, equilibration at 2° C. for 24 hr.

	Residual free dye concentration ($M \times 10^{-5}$/ml.)	Moles dye bound per mole protein*
Buffer control	6·72	
Native bovine albumin	5·76	24
Guanidine hydrochloride denatured albumin	5·22	32
Urea-denatured albumin	4·38	61

* Assuming a mol. wt. of 69,000 for bovine serum albumin.

It may be noteworthy that this effect appears to be much more marked when denaturation is effected by urea than when it is produced with guanidine hydrochloride. Different samples of bovine albumin denatured with guanidine hydrochloride also showed greater variation in the number of dye molecules (25–38 per mole albumin) bound in the presence of identical initial dye concentration than was observed with urea-denatured albumin (53–62 per mole albumin).

Assuming that partial reversal of denaturation of the albumin takes place in spite of the rapid removal of the denaturing agents by dialysis, it appears significant that denaturation with urea and guanidine hydrochloride causes no decrease in the amount of organic anion bound to the albumin; rather, in agreement with theory, it causes an increase in the number of bound dye molecules depending on the statistical distribution of uncoiled, partially coiled, and 'native' molecules in a denatured protein solution. The loss of binding affinity for organic anions observed with heat-denatured albumin probably represents a special case and not a general property of 'denatured' bovine serum albumin.

The assistance of Mrs. Marilyn C. Harris and Mrs. Marian Spiro in these experiments is gratefully acknowledged. This investigation was supported in part by a grant of the U.S. Public Health Service, National Institutes of Health.

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Decarboxylation of Collagen

Investigations in this department into the nature of the chrome tanning process have involved the preparation of various modified forms of collagen. Among possible modifications, the decarboxylation of collagen appeared to be of interest, although it has received scant attention from previous workers. Fox[1] reported that Grignard reagents had been used for decarboxylating an esterified polypeptide with the formation of a tertiary alcohol; more recently, Fromageot *et al.*[2] have used lithium aluminium hydride to reduce the terminal carboxyl groups of insulin to primary alcohols.

Collagen in the form of finely divided 'hide powder' was therefore treated with these reagents, and the dicarboxylic amino-acid content estimated by the method of Consden, Gordon and Martin[3]. Methylated collagen (0·86 m.mole OMe/gm. collagen) was treated with the Grignard reagent, methyl magnesium iodide, for 18 hr. Lithium aluminium hydride was dissolved in *n*-dibutyl ether and allowed to react with the hide powder for 12 hr. at 40° C. The metallo-protein complex formed in each case was decomposed by the addition of dilute mineral acid. The modified collagens produced were then washed with distilled water until free of salts. Analysis

Treatment	Total side-chain carboxyl	Glutamic acid	Aspartic acid	Amide-nitrogen
None	1·24	0·75	0·47	0·26
Methyl magnesium iodide	1·05	0·62	0·40	0·25
Lithium aluminium hydride	0·43	0·18	0·20	0·14

yielded the results shown in the accompanying table (expressed as m.mole/gm. dry protein).

It is seen that treatment of the methylated collagen with methyl magnesium iodide brings about a small reduction in the number of side-chain carboxyl groups. Lithium aluminium hydride, on the other hand, appears to effect more extensive reduction of the carboxyl group. In accordance with the work of Morrison *et al.*[4], some reduction of the amide groups was also observed.

It is hoped to publish full details of this work in the *Journal of the Society of Leather Trades Chemists.*

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Determination of Glycerol in Fermentation Solutions: a Rapid Chromatographic Procedure

A RAPID and simple chromatographic procedure has been developed in this laboratory for the determination of glycerol in solutions obtained by the sulphite fermentation process of Cuban blackstrap molasses, and it is considered that the method may have wider applications. Neish[1] has described a chromatographic procedure for the determination of glycerol present in amounts up to about 5 mgm. in small samples of fermentation solutions. The present method is suitable for the determination of glycerol which may be present in amounts of the order of 500 mgm., thus permitting the use of a volumetric procedure for the final determination of glycerol.

It has been shown that glycerol is readily separated from sugars by partition chromatography on paper strips, and a number of solvents may be employed[2]. This was confirmed with acetone—a solvent easily separated from glycerol by distillation. It was found, however, that when the same solvent was employed in conjunction with large samples and columns of cellulose, glycerol could not be easily separated from sugars or the fermentable constituents of molasses; but excellent separation was obtained when alumina was used as adsorbent under the conditions described below, and the glycerol could be determined in the eluate by oxidation with sodium metaperiodate and direct titration of the formic acid produced[3].

The preliminary experimental work was carried out employing samples of molasses to which known amounts of glycerol were added. In addition to the unfermentable constituents and residual unfermentable organic impurities which are present in fermented liquors, molasses also contain large concentrations of fermentable sugars which cause serious interference with the 'periodate' procedure for glycerol. This imposed more rigorous conditions on the chromatographic procedure. In order to avoid strong retention of glycerol by the other constituents of fermentation solutions, it was found necessary to add a small amount of acetic acid to the solution of the sample and to the solvent employed for extraction.

The chromatographic method involves the preparation of a column of coarse-grade cellulose powder (2·5 gm.) (Whatman), which acts as a support for chromatographic alumina (5 gm.)[4]. Sufficient of the sample is taken to give up to about 0·5 gm. glycerol. It should contain about 3 ml. water, its volume being 5 ml. (approximately). Sulphite fermentation solutions analysed in this laboratory contained glycerol in concentrations up to 12 per cent. After addition of sodium sulphite (0·5 gm.), sodium acetate (1 gm.) (these compounds assist in the retention of sugars and impurities by the adsorbent) and acetic acid (0·1 ml.) to the sample, the resulting solution is mixed with alumina (15 gm.) and the mixture then transferred to the prepared column. The glycerol is eluted with 250 ml. of solvent (acetone containing 5 per cent v/v water and 0·05 per cent v/v glacial acetic acid).

It was found that there is a small but constant retention of glycerol by the alumina adsorbent; but this difficulty was easily overcome by standardizing the caustic soda solution for the procedure, using 1 gm. molasses to which a known amount of glycerol had been added.

Employing the procedures described, typical results for the recovery of glycerol from mixtures with Cuban blackstrap molasses are given in the accompanying table. Similar results were obtained for fermentation liquors to which known amounts of glycerol had been added.

Weight of molasses (gm.)	Weight of glycerol added (gm.)	Titration (ml. 0·1 *N* NaOH)	Factor* (gm. glycerol ≡ 1 ml. 0·1 *N* NaOH)
1	Nil	0·4	—
1	0·7500	80·4	0·0094
1	0·3333	35·8	0·0094
1	0·2499	27·0	0·0094
1	0·0833	9·1	0·0096

* Theoretical value = 0·0092 (value which would be obtained in the complete absence of glycerol hold-up).

A mixture of 0·1 gm. each of sucrose, glucose and mannitol gave a titration of only 0·3 ml. 0·1 *N* sodium hydroxide. The total amount of material extracted from a mixture of 0·3 gm. each of these compounds was less than 1 mgm., whereas when cellulose alone was used 80 mgm. was extracted.

The method has been applied to the analysis of solutions from the alkaline fermentation process of Eoff, Linder and Beyer[5].

Full details of this work will be published at a later date.

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An Occurrence of Aluminium Succinate in *Cardwellia sublimis* F. Muell.

Aluminium succinate has been found as a massive deposit in a cavity in the heartwood of *Cardwellia sublimis* F. Muell. (Proteaceæ), commonly known as northern silky oak or bull oak. This is a commercial timber tree restricted to the rain forests of tropical Queensland. The deposit occurred in a so-called 'wind shake' in a log from Jarra Creek near Tully, North Queensland. Inquiries from foresters and sawmillers indicate that such occurrences are rare. The log was about 10 ft. in girth, and the deposit apparently extended from the base to at least 25 ft. up the stem of the tree. A similar occurrence of aluminium succinate has been previously recorded[1] in *Orites excelsa* R. Br. (Proteaceæ), popularly known as silky oak or prickly ash, a timber tree of the subtropical rain forests of New South Wales. Basic aluminium succinate was also identified as a white deposit in the galleries of a longhorn beetle in timber of *Qualea* sp. (Vochysiaceæ) from South America[2].

The present deposit was a loosely aggregated greyish-white powder, which lost 41·2 per cent by weight when dried at 100° C. The alumina content of the dried material was 40·9 per cent, and of the ash 99·9 per cent. The formula for basic aluminium succinate calculated by Smith (*loc. cit.*), which would agree with this result, is $Al_2(C_4H_4O_4)_3Al_2O_3$, but Campbell *et al.* (*loc. cit.*) doubt its validity. Qualitative analysis, confirmed by Dr. F. N. Lahey of the Chemistry Department, University of Queensland, failed to reveal the presence of metals other than aluminium, or organic acids other than succinic acid. The succinic acid, purified by sublimation, was identified by melting point and mixed melting point with an authentic sample. Purification of the original sample by crystallization was impracticable, owing to its complete insolubility in a wide range of solvents; consequently the exact composition was not determined.

Samples of bark and wood from another log of *Cardwellia sublimis* from Tully contained approximately 1·09 and 0·86 per cent alumina and 2·8 and 9·7 per cent ash respectively on a dry-weight basis. The ash of bark and wood contained approximately 40·0 and 82·6 per cent alumina respectively.

The physiological significance of the accumulation of aluminium in large quantities by certain plants is obscure. Chenery[3] has suggested that this accumulation may have some value in taxonomy; and a survey was made of aluminium-accumulating species in the Queensland–New Guinea flora, using the aluminon test[3]. The occurrence of aluminium (>1,000 p.p.m.) in these plants exhibits a remarkable degree of specificity. Its taxonomic and ecological implications for the local flora will be discussed elsewhere.

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Alkaloids of *Datura innoxia*

The brief reference in *Nature* of December 13, p. 1002, to a paper by James and Thewlis[1] on the separation and identification of solanaceous alkaloids in normal and grafted plants of *Atropa belladonna* and *Datura innoxia* prompts us to place on record certain results we have obtained in a similar study. So far as we are aware, the alkaloids of *D. innoxia* have not hitherto been fully characterized[2]. James and Thewlis state that they found hyoscine and hyoscyamine to be present and, from evidence of the hyoscine : hyoscyamine ratios in the two plants and in their reciprocal grafts, have deduced that alkaloid synthesis occurs mainly in the roots.

Three samples of *D. innoxia* Miller (see Timmerman[3]), one from the 1950 crop and the others from the 1952 crop, were analysed by the method described previously[4,5], and the presence of hyoscine (0·24, 0·30 and 0·37 per cent) was confirmed. The fraction at first considered to be hyoscyamine (0·035, 0·062 and 0·073 per cent) afforded a picrate of melting point considerably below that of hyoscyamine picrate. This material, on fractional crystallization from water, gave two picrates, one of melting point 162–164° C., undepressed on admixture with authentic hyoscyamine picrate, and the other, melting point 175–176° C., undepressed on admixture with authentic meteloidine picrate. It is therefore apparent that, in addition to hyoscine and hyoscyamine, *D. innoxia* contains meteloidine. There is indirect support for this conclusion in certain discrepancies between the acidimetric and colorimetric values for hyoscyamine[1]; meteloidine does not give a colour in the Vitali–Morin test. In *ad hoc* experiments, it has been confirmed that hyoscyamine and meteloidine are not separated by the chromatographic method employed both by us and by James and Thewlis,

From an extension[5] of our earlier experiments[6] on grafts within the same genus, the simplest conclusions with respect to *D. innoxia* are that the main site of alkaloidal syntheses are the roots for hyoscine and the aerial parts for hyoscyamine; the site of synthesis of meteloidine has not been located.

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Resistance of Hop Stems to Invasion by *Verticillium albo-atrum*

Most fungi causing vascular wilts of plants enter through the roots and then invade systemically the xylem tissue of the root and stem. Their effects are usually judged by the severity of leaf symptoms, and on this criterion is based an assessment both of host resistance and of fungal pathogenicity. The extent and intensity of fungal growth in the xylem (particularly of the stem) parallels the severity of leaf symptoms, and is also used as an indication of host resistance and fungal pathogenicity[1–4].

If a host species or variety has high resistance to a particular strain of wilt pathogen, fungal in-

vasion is slight. The xylem of the root is slightly invaded, and if the fungus enters the stem, its growth there is slight and attenuated. Conversely, the xylem of a plant of low resistance becomes extensively invaded, in both root and stem.

The hop varieties *OR55* and Fuggle possess respectively high and low resistance to the virulent race of *Verticillium albo-atrum* and demonstrate the phenomena described[2]. Similar effects are seen when plants of Fuggle are infected with one or other of the two races of *V. albo-atrum* of differing pathogenicity (one mild and the other virulent)[3]. The tomato varieties Pan America and Bonny Best have respectively high and low resistance to *Fusarium oxysporum lycopersici* and also display the phenomenon of differential fungal growth within them[4,5].

Roots of wilted plants are rarely studied, the assessments of disease usually being made on the stems. Since it is well known, however, that slight fungal growth in the stems is associated with slight fungal growth in the roots, and vice versa, the natural assumption appears to have been made that the whole plant (root and stem alike) provides a medium of uniformly high or low resistance to invasion. From this assumption arises a further one, namely, that the normal stems of plants of high and low resistance are intrinsically different in their reaction to the pathogen. This appears so axiomatic that it has been used as a basis for the study of the causes of resistance to wilt pathogens. Several workers have thus investigated the action of fungal toxins on healthy stems[6,7] or attempted to isolate compounds from stems of plants of high resistance which should not (theoretically) be present in stems of plants of low resistance[8]. Such studies have, in general, revealed no differences between the stems.

The present work on hops, at the East Malling Research Station, has attempted to differentiate between stem and root reaction, and to study the reactions of stems from varieties of differing resistance when grown under uniform conditions. If stems of such varieties are invaded from their own roots, their reactions are not being tested under identical conditions, since (*a*) they are growing on roots of differing varietal status and (*b*) these roots are differentially invaded. Two methods of studying the reaction of hop stems free from the effects of these factors have been used: (1) infection through rootstocks of another variety, and (2) direct stem inoculation of one variety with strains of *V. albo-atrum* to which plants of this variety show a differential response when root-inoculated.

Grafting experiments. Reciprocal rootstock–stem grafts were made of the varieties *OR55* and Fuggle (controls being grown on their own (grafted) roots). The plants were infected through these new roots by infesting the soil with a virulent strain of *V. albo-atrum*. When infected through Fuggle roots, both *OR55* and Fuggle stems became heavily invaded and died. When infected through *OR55* roots, both became lightly invaded and showed only mild symptoms. Thus under equal root-invasion conditions, the stems of both varieties showed an equal reaction. They were thus equally resistant.

Stem inoculation experiments. Stems of the Fuggle variety, growing on their own (healthy) roots, were directly inoculated with the two races of *V. albo-atrum* (mild and virulent). Two inoculation methods were used. When a small drop of spore suspension of either race of the fungus was introduced directly into the stem xylem, both races caused only mild wilt, and grew in an attenuated fashion in the stem above the point of inoculation. When a large amount of spore suspension of either race was put into a pith cavity, both races caused severe wilt, accompanied by extensive xylem invasion. The roots on all plants remained uninvaded. These results indicate that the reaction of the Fuggle stems was not determined by the race of fungus but by the conditions of invasion. When invaded from a small inoculum in the xylem, resistance of the stems was high; when invaded from a large inoculum in the pith cavity, this resistance was either reduced or overcome. The fact that stem reaction could thus be changed shows that, although not affected by fungal strain, the stems were not functioning as purely inert growth media for the pathogens.

Somewhat similar tests of inoculum dose have been made with the two races on Fuggle roots. In this case the size of the inoculum did not affect the severity of wilt or the growth of the fungus in the plant. The mild race invariably caused mild wilt and the virulent race caused severe wilt. Roots thus seem to differ fundamentally from stems in that their resistance is related to fungal virulence and not to dose of inoculum.

The results suggest the following conclusions on the mechanism of invasion of varieties of differing resistance. The site of differential resistance is in the roots. The stems of varieties of high or low resistance show equal resistance to both strains of the pathogen. Under conditions of mild root-invasion, this resistance is high; but in a variety of low resistance the host–parasite association in the roots causes stem resistance to be reduced or overcome. The following possible reasons for this are suggested as a basis for further study: (1) A reduction of stem resistance by: (*a*) diffusion of toxins from the invaded roots; (*b*) impairment of normal root-function. (2) Increase in the invasive power of the fungus by: (*a*) establishment of a suitable 'inoculum potential'; (*b*) diffusion of fungal accelerators.

The main conclusions may be widely applicable to vascular wilts. The results of Heinze and Andrus[5] suggest a similar relationship in the case of tomato wilt (although Scheffer and Walker[9] have recently disputed this). Wardlaw's observations[10] that the pseudostem of banana could only be infected through roots are also in agreement. If, in fact, the present conclusions are of general application, they may necessitate a re-orientation of previous views on the mechanism of parasitism by vascular pathogens and suggest a new approach to the study of host resistance. The experiments are to be reported in detail elsewhere.

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Use of Repellents to simplify Insecticide Field Trials

A difficulty frequently met in insecticide field trials is that although the insecticide application may kill the insects on the treated plots at the time, these plots may be re-invaded very quickly by insects from the control plots and surrounding untreated areas. This is particularly marked in the case of trials on the control of cotton *Lygus* (*Lygus vosseleri*, Popp.), where the greater part of the damage is done by an immigration of highly mobile adults into the crop. One method of avoiding this difficulty is to use large plots of several acres in extent; but the very size of the plots seriously reduces the precision of an experimental comparison, besides being very expensive in time, materials and labour. Recent work has shown that where the principal purpose of the experiments is to study the effect of *Lygus* upon the yield of cotton, the result may be obtained very much more simply by using the repellent effect of certain insecticides.

During 1951 it was noticed that where small units of cotton, two rows of twenty plants each, scattered at random throughout a largely unsprayed field, were sprayed to 'run-off' level each week with 0·1 per cent DDT, they were quite free from signs of *Lygus* damage, while untreated plants, even in adjacent rows, showed signs of very heavy damage. Since a DDT deposit of this type takes up to twenty-four hours to kill adult *Lygus*, it was felt that this protection must have been due to a repellent effect of the insecticide.

Following this indication, laboratory experiments were carried out to investigate possible repellent effects of DDT and 'Toxaphene' deposits. Adult *Lygus* of both sexes were placed in small cages and offered a choice of treated and untreated sorghum heads as food. Approximately every ten minutes the numbers of *Lygus* on treated and untreated heads were counted. After each count the cages were shaken to dislodge feeding *Lygus* and the cages rotated through 180°.

Table 1. Total Numbers of Visits made by Adult *Lygus* to Treated and Untreated *Sorghum* Heads

	Treated	Untreated	
Trial 1	50	165	Treated *Sorghum* dipped in 0·1 per cent DDT and dried. Ten *Lygus*/cage. Two cages per trial
Trial 2	34	71	
Trial 3	20	62	
Trial 4	20	51	
Means	31	87	
Trial 5	24	180	Treated *Sorghum* dipped in 0·2 per cent 'Toxaphene' and dried. Ten *Lygus* per cage. Two cages per trial
Trial 6	11	38	
Trial 7	46	162	
Means	27	127	

Assuming that in the absence of repellent effects the numbers of visits to treated and untreated heads would have been similar, the χ^2 test shows that DDT and 'Toxaphene' deposits are highly significantly repellent to adult *Lygus* of both sexes ($P < 0{\cdot}001$).

This effect was confirmed in the field during the 1952 cotton season. Ten single rows of twenty plants each were marked out at random in a two-acre cotton strip. Five of these were sprayed to 'run-off' level with 0·2 per cent 'Toxaphene' and five with 0·1 per cent '*C.R.* 686', a systemic phosphorous insecticide. Insecticide applications were made at weekly intervals during the period of *Lygus* immigration. For the purpose of comparing damage on sprayed and unsprayed plants, the tenth row to the right of each sprayed row was taken as a control.

Towards the end of the *Lygus* attack the third, fourth, fifth and sixth leaves from the top of the plant were graded on an arbitrary scale of damage ranging from 0, for no signs of damage, to 4 for a leaf completely shredded and tattered. Counts were made on fifteen plants on each treated and control row. The results are shown in Table 2.

Table 2. Mean Grade of Damage per Leaf

Rows sprayed with 'Toxaphene'	0·79
Rows sprayed with '*C.R.* 686'	0·33
Untreated control rows	1·91

Analysis of the detailed records showed that differences between treated rows and untreated controls were highly significant ($P < 0{\cdot}001$).

A detailed examination of 15 plants in each row was also made, and the percentage of fruiting points formed up to that date which had been shed was calculated (see Table 3).

Table 3. Mean Percentage of Fruiting Points Shed

'Toxaphene' sprayed rows	7 per cent
'*C.R.* 686' sprayed rows	7 per cent
Control rows	13 per cent

For the analysis of the shedding records an angular transformation was used and the differences between treated and control rows shown to be highly significant ($P < 0{\cdot}001$).

Thus it has been shown that in a cotton field where large numbers of more attractive unsprayed plants are readily and closely available the deterrent effects of certain insecticide deposits are sufficiently strong to keep the treated plants free from *Lygus* damage. Conversely, the yield loss due to *Lygus* in unsprayed cotton may be readily estimated by using this method to protect a small proportion of the plants in the field.

This relatively simple and economical method of studying the effects of *Lygus* upon cotton yield is now being developed, and a detailed paper will be published elsewhere at a later date.

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Virus-induced Nucleolar Abnormalities in Tomato

In view of current opinions on the nature of virus particles[1], recent work carried out in this department on the effect of the 'aspermy' virus upon nuclear, and especially nucleolar, behaviour in plant cells may have a special significance. Caldwell[2] reported prophase collapse in diseased pollen- and embryo-sac mother cells in tomato, accompanied by peculiarities of nucleolar behaviour, and Wilkinson[3] has observed similar meiotic abnormalities in *Nicotiana glutinosa*. Recent examination of somatic divisions in diseased tomato and tobacco plants has revealed the occurrence of widespread nucleolar and other abnormalities, some of which recall the aberrations regarded as typical of the cell-divisions found in malignant animal tissue; for example, arrested metaphase, collapse at metaphase, spindle malformation and breakdown, tendency to form giant nuclei, etc. In particular, abnormal persistence of the nucleolar material, and sometimes an apparent multiplication of nucleolar bodies during the mitotic cycle, have been very striking. Thus, in dividing cells of root tips obtained from tomato shoots heavily infected with the 'aspermy' virus, the nucleolar material,

Cells from root tissue of diseased tomato showing collapsed metaphase and (lower) nucleolar vesicle and one-sided spindle at early anaphase. × 1,000

instead of dispersing during prophase, persists through anaphase in the form of one or more prominent and somewhat elongated vesicles. The accompanying photograph shows a typical dividing nucleus at early anaphase, with the nucleolar vesicle in a central position upon the somewhat distorted spindle; incidentally, in the cell above can be seen an example of metaphase collapse. Similar results have been obtained in tobacco species infected with the same virus.

This postponement of the utilization of nucleolar material by the contracting chromosomes, normally completed by early metaphase (when the pellicles which invest the chromosomes are fully formed), provides further support for the view that there is competition between the virus particles and chromonematal material for nucleoprotein contained in the nucleolus. This view was formulated by me at a meeting last year of the Society for the Study of Fertility and mentioned in *Nature* (August 9, 1952). A detailed account of the work is being prepared for publication.

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Polyploidy in *Primula farinosa* L.

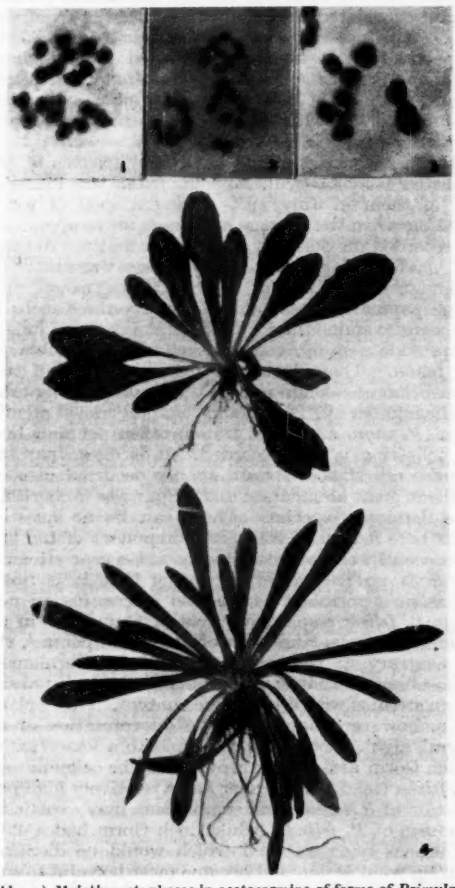
THE discovery of a tetraploid form of *Primula farinosa* on the Baltic island of Gotland during the summer of 1950 was somewhat unexpected, as hitherto this plant has seemed a well-defined diploid species ($n = 9$), at least in Central and Northern Europe. This tetraploid form revealed $n = 18$ at meiosis (Fig. 1), and the plant appeared morphologically distinct from the British *Primula*, with more elongated spatulate leaves (Fig. 4).

This led to a more comprehensive study of *P. farinosa* in Great Britain. However, all specimens collected on Widdybank Fell, Teesdale, in May 1952 proved to be diploid with $n = 9$ (Fig. 2); and a further survey of the *Primula* from other limestone areas in Yorkshire, Durham and Westmorland has so far revealed the same result; but in every case the chromosomes seemed smaller than those of the tetraploid form.

However, the intricacies of this species are considerable, and indicate a cytological complexity that was not visualized in the first instance, for plants of *P. farinosa* var. *acaulis* collected on Gotland, and kindly sent to me by Dr. Bengt Pettersson, have also proved to be diploid with $n = 9$ (Fig. 3). However, the chromosomes of this plant are considerably larger than those of the British diploid and the Swedish tetraploid (Figs. 1, 2 and 3), and a gene difference for chromosome size is therefore suspected. Thus the diploid and tetraploid forms of this species are both represented on the Baltic island of Gotland, which has for many years been renowned for its peculiar and interesting flora, rich in endemics.

These preliminary results indicate the complexity of the problem, and the tetraploid plants produce an interesting connecting link between the original diploid form of *P. farinosa* and the other members of the sub-section Farinosæ, which give rise to a very long polyploid series: *Primula farinosa*, $n = 9$; *P. farinosa*, $n = 18$; *P. scotica*, $n = 27$; *P. scandinavica*, $n = 36$; *P. stricta*, $n = 63$.

However, it is now clear that a more detailed cytological survey of this group, from all over its geographical range, is desirable. I should be most



(Above) Meiotic metaphases in acetocarmine of forms of *Primula farinosa*. × 1,200. (1) Tetraploid from Gotland; (2) diploid from Teesdale; (3) diploid from Gotland.
(Below) (4) *Primula farinosa*, above from Teesdale, below from Gotland

grateful for any living plants or seeds of *P. farinosa*, *P. scotica*, *P. scandinavica*, *P. stricta* and *P. finmarchica* from Great Britain, Europe and North and South America.

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Habitat of *Polycelis felina* (= *cornuta*) and *Crenobia alpina* in the British Isles

The few text-books on freshwater biology which refer particularly to the British Isles regard *Polycelis felina* and *Crenobia alpina* as stenothermous, stream-dwelling species. Beauchamp[1], however, showed that *C. alpina* inhabited suitable shores of some Cumberland lakes during the winter; but he considered that summer temperatures were too high for their occurrence in lakes at this season. The generally accepted view is that in the British Isles these two species cannot establish themselves where the temperature exceeds 13°–15° C. in the case of *C. alpina*[2,3] and 16°–17° C. for *P. felina*[3]. On the Continent, Theinemann[4] considered that the widest range of *C. alpina* and *P. felina* was 0·7°–15° C. and 0·5°–15·75° C. respectively. It has been reported several times from the Continent that *Crenobia alpina* is a permanent member of the fauna of Alpine and other mountain lakes where a suitable substratum occurs (for references see Beauchamp[1]).

During a survey of the freshwater triclads of the lochs on Islay (Argyll), *Polycelis felina* was found in six of them in July 1952 during a spell of warm weather when the average maximum air temperature, as recorded on Colonsay, was 20° C. and the average 16° C., following a June of average warmth. Its abundance varied from a small to an exceedingly large population (see table). Twenty-three lochs in all were examined, and of these eleven were judged to provide a stony, wave-washed shore suitable for *P. felina*. These lochs are listed in order of concentration of calcium ions in the accompanying table —the number of *P. felina* and the total triclad population (*P. nigra* and/or *P. tenuis*) taken per unit hour of collecting is also recorded. It is clear that this supposedly typical stream species occurred in some lochs in great abundance, and in four was numerically the dominant species. There can be no question that here it formed a typical component of the lake fauna and was not restricted to areas near streams; there is no reason for supposing that it is not a permanent member. It is also interesting to note that *P. felina* reached its greatest abundance in the more calcareous lakes. According to Carpenter[2], this is contrary to the view expressed by Bornhauser, who observed that this species was markedly absent from streams with a high lime content. The explanation, however, may lie in the interpretation of the term 'high'. Loch Finlaggin, and to a lesser extent Loch Gorm also, are exceptions to the calcium ion – *P. felina* trend. The former had a relatively high population of *P. tenuis*, and competition may explain the absence of *P. felina*; while Loch Gorm had a shore of stones lying on sand which would be disturbed during wind action and become most harmful to soft-bodied triclads.

Considering now *Crenobia alpina*, this species was not recorded from the Islay lochs, but was collected from Loch Baile à Ghobhain and Loch Fiart on Lismore Island, and from Loch Restil (Argyll) in July 1951. The former two are low-lying, calcareous lochs (calcium, 50 mgm./l.) and the triclads were taken from exposed, stony shores. In more sheltered bays, *C. alpina* was absent and *Polycelis nigra* occurred. Loch Restil is a small, lime-poor (calcium, 2·4 mgm./l.) hill loch at approximately 800 ft. above sea-level. At the time, the records were considered as examples of aberrant behaviour, perhaps due to the drying-up of streams. However, on the clear-cut evidence of the Islay records for *P. felina*, they may be better regarded as examples of the lake-dwelling habit of *C. alpina* in the British Isles.

Loch	Calcium (mgm./l.)	*P. felina* (1 hr. collecting)	Total triclads	Loch type	Height above sea-level (ft.)
nam Ban	1·6	Nil	Nil	Hill loch	350
Cam	2·8	Nil	20	Hill loch	300
Ardnahoe	2·8	81	162	Hill loch	200
nan Gillean	4·4	Nil	248	Hill loch	300
Gerarch	4·8	Nil	Nil	Peaty hill loch	250
Gorm	8·8	8	16	Coastal loch—sandy	50
Skerrols	9·6	140	216	Lowland loch	75
Finlaggin	15·6	Nil	210	—	170
Lossit	16·4	324	324	Hill loch	300
Cadharn	19·2	346	442	Hill loch	230
Ballygrant	23·2	228	264	Hill loch	230

It is generally considered that these two triclads are limited in their distribution by their stenothermy, or associated oxygen tension[5]. Examination of average maximum July air temperatures for the British Isles (1901–30) shows that Islay, by virtue of its maritime position, lies north of the 62° F. (16·7° C.) isotherm; Lismore is 1°–2° F. warmer. Allowing for the lower temperature of lake water and the certainty of periods of average temperature greater than 16·7° C. (average annual maximum temperature for Islay, 1901–30, was approximately 22·5° C.), the habit may still fit with the physiological explanation, particularly in the case of *P. felina*. (It is hoped to arrange for water temperatures to be recorded in one of the Islay lochs during the summer.) Thus *P. felina* and perhaps *C. alpina* may be permanent lake-dwellers in the northern part of the British Isles, but confined to streams farther south. *P. felina* was recorded from a stony beach in Windermere during August 1950, but during a period of heavy rainfall and near the entry of a stream.

Different varieties of *P. felina* have been described by Theinemann, and it will be interesting to compare the Islay loch specimens with stream-dwelling forms. Living collections of Islay material have been submitted to Mr. Anders G. Dahm, University of Lund, Sweden, who is working on the taxonomy and ecology of this species.

I am grateful to the Nature Conservancy for defraying expenses for the field-work, and to the Meteorological Office for supplying data of temperatures for Colonsay.

T. B. Reynoldson
Department of Zoology, University College of North Wales, Bangor. Oct. 25.

[1] Beauchamp, R. S. A., *J. Anim. Ecol.*, **1**, 175 (1932).
[2] Carpenter, K., *J. Ecol.*, **16**, 105 (1928).
[3] Macan, T. T., and Worthington, E. B., "Life in Lakes and Rivers", 126 (Collins, London, 1951).
[4] Theinemann, A., *Int. Rev. Hydrobiol. Biol.*, Supp. 4 (1912).
[5] de Beaufort, L. F., "Zoogeography of the Land and Inland Waters" (Sidgwick and Jackson, London, 1951).

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, April 13

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Relative Merits of Broad-Band Transmission by Beam, Cable and Waveguide" (to be opened by Mr. E. C. H. Organ).

SOCIETY FOR GENERAL MICROBIOLOGY (at the Royal Institution, 21 Albemarle Street, London, W.1), at 6 p.m.—Dr. D. D. Woods: "The Integration of Research on the Nutrition and Metabolism of Micro-organisms" (First Marjory Stephenson Memorial Lecture).*

Monday, April 13—Thursday, April 16

ERGONOMICS RESEARCH SOCIETY (in the Department of Human Anatomy, The University, Oxford).—Symposium on "Human Performance—its Measurement and Limitations".

Monday, April 13—Friday, April 17

PHYSICAL SOCIETY (at the Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7).—37th Exhibition of Scientific Instruments and Apparatus.

Tuesday, April 14

At 6.45 p.m.—Dr. E. C. Bullard, F.R.S.: "Seismic Study of the Ocean Basins".

Wednesday, April 15

At 6.45 p.m.—Dr. L. A. Jordan: "Particles, Pellicles; Pigments, Paints and Physics".

Thursday, April 16

At 6.45 p.m.—Prof. W. V. Mayneord: "Scintillation Counting and its Medical Applications".

Tuesday, April 14

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. G. G. Haselden: "The Fractionation of Liquid Air".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. T. Kilburn, Mr. G. C. Tootill, Mr. D. B. G. Edwards and Mr. B. W. Pollard: "Digital Computers at Manchester University"; Mr. B. W. Pollard and Mr. K. Lonsdale: "The Construction and Operation of the Manchester University Computer"; Dr. T. Kilburn and Mr. G. Ord: "Universal High-Speed Digital Computers—a Decimal Storage System"; Prof. F. C. Williams, F.R.S., Dr. T. Kilburn, Mr. G. N. W. Litting, Mr. D. B. G. Edwards and Mr. G. R. Hoffman: "Recent Advances in Cathode Ray Tube Storage".

INSTITUTION OF THE RUBBER INDUSTRY (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Annual General Meeting; at 7 p.m.—Films: "Basic Principles of Lubrication", "Krilium".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, POLAROGRAPHIC DISCUSSION PANEL of the PHYSICAL METHODS GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Papers on "Polarography".

Wednesday, April 15

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. L. Landon Goodman: "Materials Handling and Processing".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. Maurice Black: "The Constitution of Chalk".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Annual General Meeting; Sir Charles Normand: "Monsoon Forecasting" (Presidential Address).

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Prof. B. K. Johnson: "Microscopy in the Region of Wave-length $\lambda = 2000$ A. to 1000 A."; Mr. R. J. King and Dr. E. M. F. Roe: "Optical Conditions for Quantitative Ultra-Violet Microspectroscopy".

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. F. C. Porter: "The Corrosion of Aluminium and its Alloys in Supply Waters".

Thursday, April 16

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. K. A. Kermack: "A Biometrical Study of *Micraster coranguinum* and *Isomicraster senonensis*"; Mr. E. Nicolai and Mr. R. D. Preston: "Cell Wall Studies in the Chlorophyceae".

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. Shiou-Chuan Sun: "Frothing Characteristics of Cresylic Acids in Flotation"; Dr. J. S. Webb: "A Review of American Progress in Geochemical Prospecting and Recommendations for Future British Work in this Field".

LONDON MATHEMATICAL SOCIETY (at University College, Cardiff), at 5 p.m.—Dr. G. Higman: "p-soluble Groups".

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (at the Building Centre, Store Street, London, W.C.1), at 6 p.m.—Annual General Meeting; Mr. A. W. Christie: "Road Surfaces as Reflectors of Light, from the Point of View of Street Lighting".

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGY GROUP (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 6.15 p.m.—Dr. Lois Dickinson: "The Use of the Bacteriophage in the Study of Viruses"; Mr. L. J. Meanwell: "Bacteriophages of the Lactic Streptococci".

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 8 p.m.—Dr. A. E. Jones and Dr. A. Glucksmann: A Discussion on "The Carcinogenic Effects of Radiation".

Thursday, April 16—Saturday, April 18

FARADAY SOCIETY (at the Royal Institution, 21 Albemarle Street, London, W.1).—Fiftieth Anniversary Celebrations, and General Discussion on "Equilibrium Properties on Solutions of Non-Electrolytes".

Friday, April 17

INSTITUTION OF CHEMICAL ENGINEERS, GRADUATES' AND STUDENTS' SECTION (in the Large Chemistry Theatre, University College, Gower Street, London, W.C.1), at 10 a.m.—Symposium on "Effluent Disposal".

ASSOCIATION OF APPLIED BIOLOGISTS (in the Surveying Lecture Theatre, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7), at 11 a.m.—Annual General Meeting; at 2.30 p.m.—Mr. R. W. Marsh: "The Past and Future of the *Annals of Applied Biology*" (Presidential Address).

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Discussion of Geophysical Papers received during the Session.

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Annual General Meeting; at 7.30 p.m.—Dr. Wm. Mitchell: "Isolation of Fine Chemicals from Natural Sources".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER OR ASSISTANT LECTURER IN THE DEPARTMENT OF PHARMACEUTICS, University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (April 18).

SPEECH THERAPIST (part-time) to the Godalming Clinic—The County Medical Officer, County Hall, Kingston-upon-Thames, Surrey (April 18).

LECTURERS IN ANATOMY, PHYSIOLOGY and PATHOLOGY, and LECTURERS OR ASSISTANT LECTURERS IN CIVIL ENGINEERING AND MECHANICAL ENGINEERING, at University College of Khartoum, Sudan—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (April 20).

RESEARCH ASSISTANT IN THE DEPARTMENT OF CHEMISTRY, for work on ionic melts—The Professor of Chemistry, Queen's University, Belfast (April 20).

LIGHT CURRENT ELECTRICAL ENGINEER at the Royal Aircraft Establishment, Farnborough, for development of variety of precision electrical equipment and its application to research problems in aircraft flight control—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.114/53A (April 25).

PHYSICAL CHEMIST OR PHYSICIST (Scientist, Grade I) to take charge of investigations on the structure of coke—The National Coal Board, Central Research Establishment, Stoke Orchard, Cheltenham, Glos, quoting TT/611 (April 25).

ASSISTANT LECTURER IN THE DEPARTMENT OF CHEMISTRY—The Secretary and Registrar, University College of North Wales, Bangor (April 27).

DIRECTOR OF THE TASMANIAN MUSEUM AND ART GALLERY—The Agent-General for Tasmania, 457 Strand, London, W.C.2 (April 30).

RESEARCH OFFICERS (Scientific Officer grade) to work on sugar beet breeding and cereal breeding—The Secretary, Plant Breeding Institute, School of Agriculture, Cambridge (April 30).

RESEARCH STUDENTSHIPS to senior undergraduates reading zoology—The Director, Zoological Society of London, Regent's Park, London, N.W.1 (April 30).

SENIOR LECTURER IN THE DEPARTMENT OF VETERINARY PATHOLOGY—The Secretary of University Court, The University, Glasgow (April 30).

UNIVERSITY LECTURER and one or more UNIVERSITY ASSISTANT LECTURERS IN MATHEMATICS—The Secretary of the Faculty of Mathematics, Arts School, Bene't Street, Cambridge (April 30).

ASSISTANT IN PHYSICAL CHEMISTRY at University College, Dundee—The Secretary, The University, St. Andrews (May 1).

LECTURER OR ASSISTANT LECTURER IN CHEMISTRY at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (May 1).

SENIOR LECTURER IN INORGANIC CHEMISTRY, and LECTURERS OR ASSISTANT LECTURERS IN BOTANY, CHEMISTRY, MATHEMATICS, PARASITOLOGY, and ZOOLOGY, at University College of Khartoum, Sudan—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (May 1).

LECTURER IN PUBLIC HEALTH ENGINEERING—The Head of the Department of Civil Engineering, Imperial College of Science and Technology, South Kensington, London, S.W.7 (May 2).

RESEARCH ASSISTANT TO WORK IN BEEKEEPING RESEARCH DEPARTMENT on problems relating to honey bees and their management—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (May 5).

ASSISTANT LECTURER IN CHEMISTRY, and an ASSISTANT LECTURER IN ZOOLOGY—The Registrar, University College, Cathays Park, Cardiff (May 9).

LECTURER IN THE HISTORY OF SCIENCE—The Secretary of Faculties, University Registry, Oxford (May 9).

ENGLISH ELECTRIC CO. STUDENTSHIP IN AERONAUTICS—The Deputy Registrar, City and Guilds College, Exhibition Road, London, S.W.7 (May 15).

ENTOMOLOGIST, and a RESEARCH OFFICER—The Director, Tobacco Research Board of Southern Rhodesia, P.O. Box 1909, Salisbury, Southern Rhodesia (May 15).

MAHENDRALAL SIRCAR PROFESSOR OF PHYSICS—The Registrar, Indian Association for the Cultivation of Science, Jadavpur, Calcutta 32, India (May 15).

ORGANIC CHEMIST (Senior Research Officer grade)—The Director, Laboratory of Human Nutrition, Oxford (May 16).

SCIENTIFIC OFFICER IN THE ENTOMOLOGY DEPARTMENT, to work probably on problems of soil arthropods or other invertebrates—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (May 16).

SENIOR RESEARCH OFFICER to undertake research on the kinetics of the gasification reactions of coal under high pressure, a RESEARCH OFFICER to undertake research on the influence of ash catalysis on the reactions which occur during the complete gasification of coal, a RESEARCH OFFICER to undertake research directed at the improvement of methods for the analysis and testing of brown coal, and gas mixtures which result from its gasification, a TECHNICAL OFFICER to undertake the analysis and testing of coal, ash, fuel gases, and other materials associated with the pilot plant investigation of the gasification of brown coal, a TECHNICAL OFFICER to assist in pilot plant research on the gasification of coal under high pressure, and a TECHNICAL OFFICER to develop techniques for the investigation of the sintering and fusion of coal ash; in the Chemical Engineering Section of the Division of Industrial Chemistry, Commonwealth Scientific and Industrial Research Organization—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Ref. 590/439 (May 16).

UNIVERSITY DEMONSTRATOR IN BOTANY—Dr. A. S. Watt, Department of Botany, Downing Street, Cambridge (May 16).

ASSISTANT LECTURER IN ARCHÆOLOGY—The Registrar, University College, Cathays Park, Cardiff (May 30).

COATS FELLOWSHIP IN CHEMISTRY or PHYSICS—The Clerk of the Senate, The University, Glasgow, W.2 (May 31).

ORNITHOLOGIST (Professional Officer grade), an ENTOMOLOGIST (Assistant Professional Officer grade) and a HERPETOLOGIST (Assistant Professional Officer grade)—The Director, Transvaal Museum, P.O. Box 413, Pretoria, South Africa (May 31).

ASSISTANT LECTURER IN BOTANY—The Registrar, University College, Exeter.

ASSISTANT TECHNICAL SECRETARY (with a degree in metallurgy) TO THE METALLURGY (General) DIVISION—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting 'Technical Secretary'.

ENTOMOLOGIST to develop a field technique to control biting midges, and a TECHNICAL ASSISTANT graduate or technician to assist in investigating the larval ecology of midges—Dr. D. S. Kettle, Department of Zoology, West Mains Road, Edinburgh 9.

EXPERIMENTAL OFFICERS (preferably biologists, but chemists or physicists with interest in biological research acceptable) at a Ministry of Supply Research Establishment near Salisbury—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting G.99/53A.

EXPERIMENTAL OFFICERS in R.A.F. Signals Establishments at (*a*) Ruislip, for general experimental work and tests in connexion with design of radio communications and radar systems, (*b*) Medmenham, for work on installation design of airfield communications and landing aid systems, equipment, investigations and siting problems, (*c*) Henlow (Assistant Experimental Officers only) for experimental work on calibration of transfer standards, involving bridge, frequency, and pulse measurements—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.90/53A.

LECTURER (Grade B) IN THE HYGIENE AND PUBLIC HEALTH DEPARTMENT—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11.

MECHANICAL ENGINEER or PHYSICIST (with first- or second-class honours degree or equivalent in mechanical engineering or physics) to undertake experimental and theoretical work with light mechanisms, at the Royal Aircraft Establishment, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting C.169/53A.

METALLURGIST or PHYSICAL CHEMIST (with university degree or equivalent qualification) to carry out research involving particular emphasis on vacuum melting of pure iron and special alloys (location of work: Sheffield)—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting 'Vacuum Melting'.

RESEARCH ASSISTANT (with experience in algology, preferably with unicellular algæ) for work in biophysics IN THE DEPARTMENT OF BOTANY—Dr. R. D. Preston, Department of Botany, The University, Leeds 2.

RESEARCH ASSISTANT (with honours degree in engineering) for measurements for the elastic and plastic states for a metal-working process—Prof. Ford, Mechanical Engineering Department, City and Guilds College, Exhibition Road, London, S.W.7.

RESEARCH ASSISTANT (Inter.B.Sc. standard) for chemical investigations on the interaction of ink and paper—The Printing, Packaging and Allied Trades Research Association, Randalls Road, Leatherhead, quoting C.2.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Observations made at the Royal Observatory, Greenwich, in the Year 1938, in Astronomy, Magnetism and Meteorology, under the direction of Dr. H. Spencer Jones. Pp. viii+A60+B8+C1x+C163+xx+D83+45. (London: H.M. Stationery Office, 1951.) £6 net. [52

Royal Institute of Chemistry. Lectures, Monographs and Reports, 1952, No. 4: The Scientific Examination of Paintings. By Dr. A. E. A. Werner. Pp. 16. (London: Royal Institute of Chemistry, 1952.) 5*s.* net. [52

List of Books and Pamphlets (concluded September 1952) in Special Library of Industrial Diamond Information Bureau. Pp. 215. (London: Industrial Distributors (Sales), Ltd., 1952.) Free. [52

British Commonwealth Scientific Conference, Australia, February–March 1952. Report of Proceedings. Pp. vi+74. (London: H.M. Stationery Office, 1952.). 3*s.* net. [92

The Calendar: Past, Present and Future. By Sir Harold Spencer Jones. Pp. 27. (London: World Calendar Association, 1953.) 1*s.* [92

British Hydromechanics Research Association. Fifth Annual Report, October 1951 to September 1952. Pp. 28. (Harlow: British Hydromechanics Research Association, 1952.) [92

Transactions of the Royal Society of Edinburgh. Vol. 62, Part 2, No. 9: Geology of Central Vestspitsbergen. Part 1: Review of the Geology of Spitsbergen, with special reference to Central Vestspitsbergen; Part 2: Carboniferous to Lower Permian of Billefjorden. By E. R. Gee, W. B. Harland and J. R. H. McWhae. Pp. 299–356+7 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1952.) 18*s.* 6*d.* [92

Other Countries

Acta Psychiatrica et Neurologica Scandinavica. Supplementum 79: A Study in Manic-Depressive Psychosis; Clinical, Social and Genetic Investigations. By Åke Stenstedt. Pp. v+111. (Copenhagen: Ejnar Munksgaard, 1952.) 20 Swedish crowns. [52

Dominion of Canada: Department of Agriculture, Science Service. Guide to the Chemicals used in Crop Protection. By H. Martin and J. R. W. Miles. Pp. 236. (London, Ont.: University of Western Ontario, 1952.) [52

Meddelanden från Lunds Astronomiska Observatorium. Ser. 1, Nr. 179: A Radar Investigation of the Delta Aquarid Meteor Shower of 1950. By Bertil-Anders Lindblad. Pp. 27. Ser. 1, Nr. 180: On the Masses and Luminosities of Extragalactic Nebulae. By Erik Holmberg. Pp. 13. (Göteborg: Elanders Boktryckeri A.-B., 1952.) [52

Research Bulletin of the East Punjab University. No. 16: Sperm Formation in certain Coleoptera with particular reference to Chromosome Numbers, Acrosome and Mitochondrial Nebenkern. By Vishwa Nath, Rajkrishnan Bhardwaj and Manohar Lal Gupta. Pp. 39–50. 3 rupees. No. 17: Potassium Meta-Periodate as Volumetric Agent, Part 2, Indirect Determinations. By Balwant Singh and Appar Singh. Pp. 51–56. 13 annas. No. 18: Studies on the Hariana Breed of Cattle. By G. P. Sharma, K. N. Vali and K. R. Suri. Pp. 57–68. 1.8 rupees. No. 19: Preparation of Active Carbon from a few Indigenous Sources and Comparative Efficiency of Different Activation Treatments. By Balwant Rai Puri, M. L. Lakhanpal and Balvir Varma. Pp. 12. 1.8 rupees. (Hoshiarpur: East Punjab University, 1951–1952.) [52

Proceedings of the Symposium on Indian Oils and Fats and their Utilization at the National Chemical Laboratory of India, Poona, 7th–9th November 1951, presided by Prof. J. W. McBain. Edited and published by Dr. J. S. Aggarwal. Pp. vii+266. (Poona: National Chemical Laboratory, 1952.) 1 rupee. [52

Indian Central Cotton Committee. Technological Bulletin, Series A, No. 79: Technological Reports on Standard Indian Cottons, 1951. By Dr. C. Nanjundayya. Pp. iv+88. (Bombay: Indian Central Cotton Committee, 1952.) 2 rupees. [52

Guide to the Botanic Gardens, Entebbe, Uganda. Pp. ii+8+15 plates. (Entebbe: Botanic Gardens, 1952.) 2*s.* [52

Education in a Technological Society: a Preliminary International Survey of the Nature and Efficacy of Technical Education. (Tensions and Technology Series.) Pp. 76. (Paris: Unesco; London: H.M. Stationery Office, 1952.) 200 francs; 4*s.*; 75 cents. [92

Smithsonian Institution: United States National Museum. Bulletin 200: The Generic Names of the Beetle Family Staphylinidae: with an Essay on Genotypy. By Richard E. Blackwelder. Pp. iv+483. (Washington, D.C.: Government Printing Office, 1952.) 1.50 dollars. [92

Smithsonian Institution: Bureau of American Ethnology. Bulletin 145: The Indian Tribes of North America. By John R. Swanton. Pp. vi+726. 3.50 dollars. Bulletin 150: The Modal Personality Structure of the Tuscarora Indians as revealed by the Rorschach Test. By Anthony F. C. Wallace. Pp. viii+120. 60 cents. (Washington, D.C.: Government Printing Office, 1952.) [92

Catalogues

Platinum: Rhodium-Platinum Thermocouples. (Publication 1550.) Pp. ii+18. (London: Johnson, Matthey and Co., Ltd., 1952.)

The Complete Spraying Programme, 1953. Pp. 96+8 plates. (Wheathampstead: The Murphy Chemical Co., Ltd., 1953.)

Light's Organic Chemicals. Pp. 36+iv. (Colnbrook: L. Light and Co., Ltd., 1953.)

Sunvic Industrial Control. Pp. 4. (London: Sunvic Controls, Ltd., 1953.)

Preservatives, Antiseptics, Antioxidants. Pp. 4. (Treforest: Nipa Laboratories, Ltd.; London: P. Samuelson and Co., 1953.)

Chemicals and Reagents for use in Research, Analysis, Education, Industry. (Catalogue No. 66CR.) Pp. iv+60. (London: Griffin and Tatlock, Ltd., 1953.)

B.D.H. Adsorption Indicators. Second edition. Pp. 32. (Poole: British Drug Houses, Ltd., 1953.)